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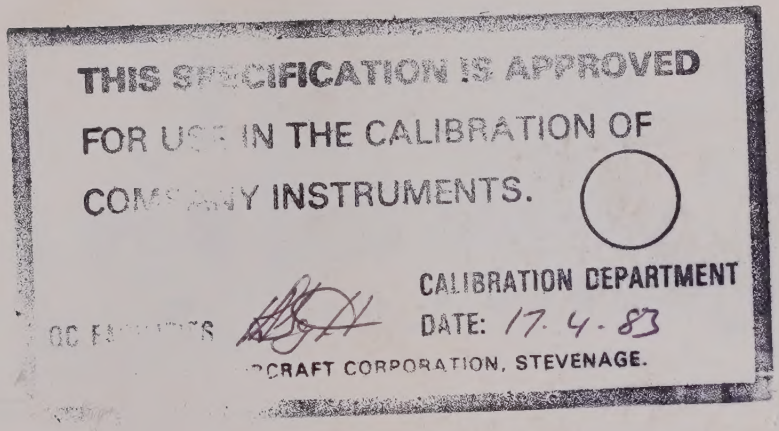
TECHNICAL DATA

A100
OSCILLOSCOPE
SYSTEM



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1972

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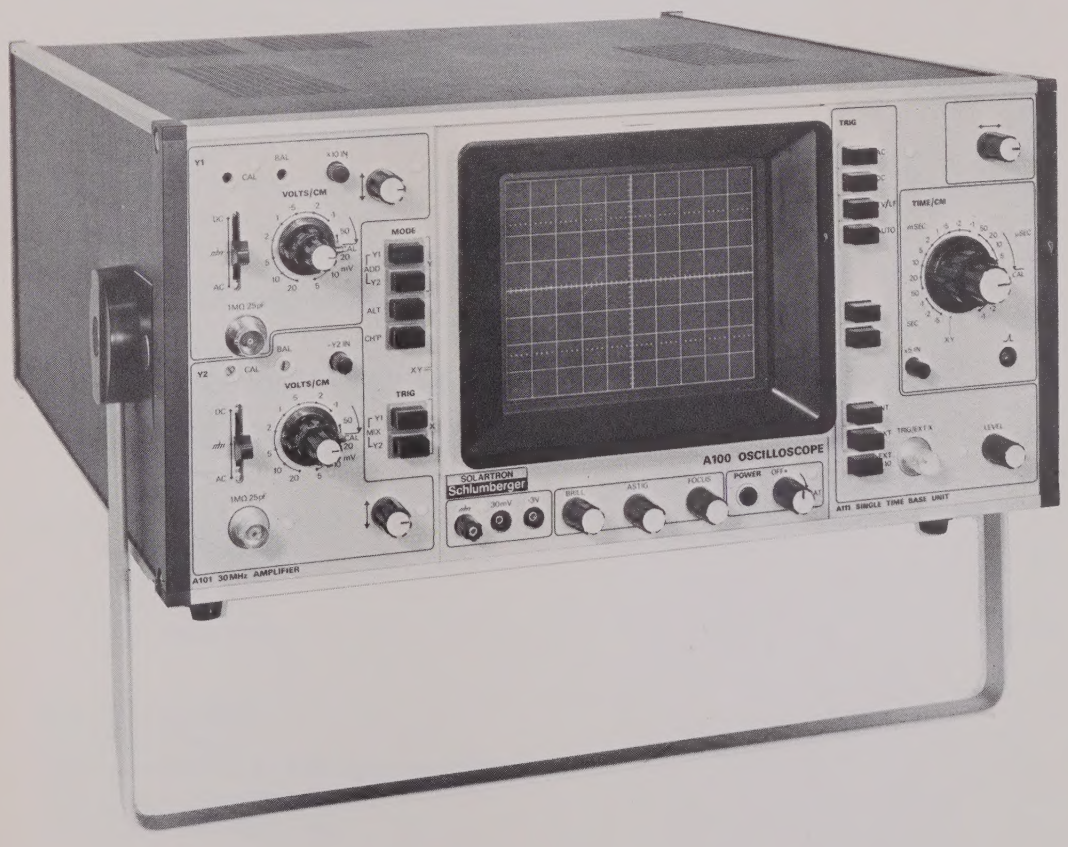
OSCILLOSCOPE SYSTEM A100



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CONTENTS

INTRODUCTION 1.1

CONTROLS AND CONNECTORS
A100 Main Frame Unit 2.1
A101 Dual Vertical Deflection Amplifier 2.2
A111 Single Timebase Unit 2.3
A112 Dual Timebase Unit 2.4

PRELIMINARY OPERATIONS
Initial Checks 3.1
Initial Trace Finding 3.1
User Calibration 3.2

NORMAL OPERATING PROCEDURES
A101 Dual Vertical Deflection Amplifier
- Input Connections 4.1
- Triggering 4.3
- Single Trace ac 4.4
- Single Trace ac (setting dc zero) 4.5
- Single Trace dc (measurement) 4.6
- Dual Trace 4.7
- Single Trace Added (Y1 + Y2) 4.8
- Single Trace Added (Y1 - Y2) 4.9

A111 Single Timebase Unit
- Triggering 4.10
- AUTO triggering 4.10
- Normal triggering (level controlled) 4.12
- Pulse triggering 4.13
- XY Plotting 4.14

A112 Dual Timebase Unit
- Delayed Sweep Mode 4.16
- Single Shot 4.17
- Television signal 4.18
- Trace Photography 4.20

SPECIFICATIONS
A100 Main Frame 5.1
A101 Dual Vertical Deflection Amplifier 5.2
A111 Single Timebase Unit 5.3
A112 Dual Timebase Unit 5.5

THE CX3500 PROBE 6.1

INTRODUCTION TO SERVICING MANUAL 7.1
- A100R Rack Mounting 7.3

MAIN FRAME A100
General Information 8.1
Power Supplies 8.6
CRT and Bright-up 8.10
EHT Generator and Calibrator 8.14
Parts Lists 8.18

DUAL TRACE Y AMPLIFIER A101
General Information 9.1
Attenuators 9.4
Pre-amplifiers 9.6
Output Amplifier and Local Supplies 9.12
Beam Switch 9.16
Parts Lists 9.18

SINGLE TIMEBASE A111
General Information 10.1
Input Amplifier and Switching 10.4
Trigger Generator 10.6
Ramp Generator 10.8
Output Amplifier and Local Supplies 10.12
TIME/CM SWITCH 10.16
Parts Lists 10.16

DUAL TIMEBASE A112 (to be issued later)

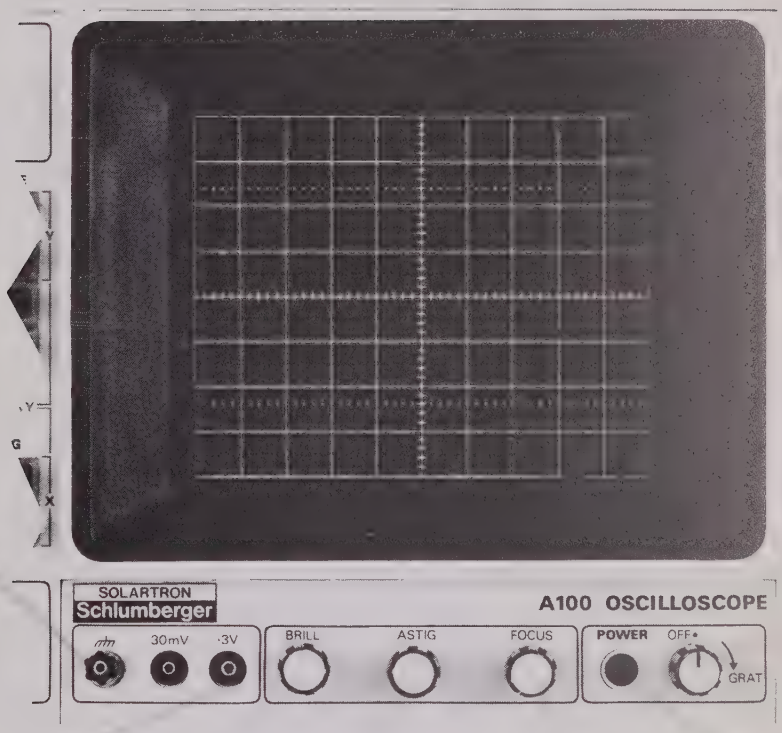
INTRODUCTION

This manual contains the calibrating and operating procedures for the A100 oscilloscope system.

After the preliminary introductions and control function descriptions, the procedures begin with initial checks and calibrating instructions. The normal operating procedures then follow.

The operating procedures are provided mainly for the inexperienced user, and refer, in places, to the basic principles of oscilloscope use. These procedures may also be useful, however, to the more experienced for reference to specific information.

A full technical specification for each of the sub-units is given in section 5 of this manual.



Chassis/Earth Socket (2mm)
A signal earth point, connected to chassis and, via the mains lead, to mains earth. Its wiring is of insufficient gauge for use as a power earth.

Calibration (30mV and 0.3V)
2mm sockets delivering 1kHz square-wave reference signals for calibrating the X and Y modules.

BRILLiance
A continuously variable control which gives maximum trace brightness when fully clockwise.

ASTIGmatism
This control determines spot shape and should be used in conjunction with BRILL and FOCUS to obtain optimum trace definition. On later models, this is a front-panel preset control.

FOCUS
A variable control which pr
timum focus at approxima
position.

A100
MAIN FRAME UNIT

INTRODUCTION

This unit contains the display tube, power supplies, and calibration circuits. It also provides two housings which accommodate the sub-units. A complete oscilloscope is formed by assembling a Y unit into the left-hand housing and an X unit into the right-hand housing. The complete instrument is available in two forms.

[a] A100, in a portable bench type case.

[b] A100R suitable for 19in. rack mounting.

With the exception of minor chassis differences and dimensions, both instruments are identical. All instructions contained in this manual apply to either assembly.

Power

Mains ON/OFF switch, ganged to the graticule illumination control. Maximum graticule illumination is obtained with the control fully clockwise.

Graticule illumination is normally required only when a hood or camera is used. For use in normal lighting conditions therefore, and in the absence of a hood or camera, the control should be set to minimum in order to preserve filament life.

Power Indicator

Indicates that the +ve and -ve stabilised d.c. supply rails are functioning and that the instrument has warmed up and is ready for use.

Reduced brilliance indicates a supply fault condition.

op-
nid'

◄CONTROLS AND CONNECTORS

CALibration
A preset control used for fine adjustment of the sensitivity ranges.

BALance
A preset, fine adjustment, control used to balance out slight trace movement as sensitivity is changed.

X10 IN
A push-button switch which, w
pressed, increases the selected
tivity of the Y1 channel only
factor of 10. Under these con
the bandwidth is 5Hz to 2

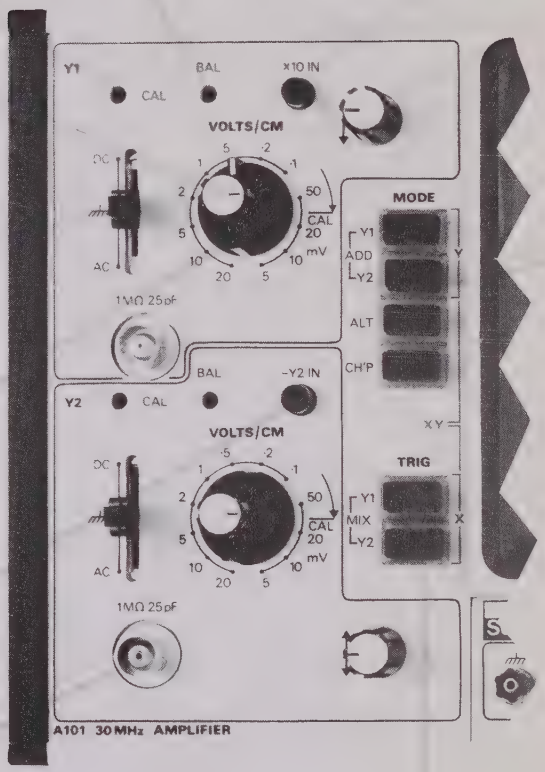
Fine Gain Control
A variable control which may be used to decrease the selected sensitivity by a factor of 2.5. The control has unlimited rotation with a spring loaded detent at CAL.

Input Coupling Selector
A three position lever switch which provides selection of either AC or DC coupling, or earth. In the centre, earth, position [⏚] the input socket is isolated and the amplifier input is connected to chassis.

Sensitivity Selector (VOLTS/CM)
A twelve position rotary switch which selects the required sensitivity, within the range 5mV/cm to 20V/cm. The ranges are calibrated when the fine gain control is set to CAL.

Y2 Invert Selector
A push-button switch which, when depressed, inverts the Y2 trace.

Input Socket
A BNC type connector.



Trigger Source Selector
Two push-button switches which select the channel routed to the X unit for triggering purposes.

Shift Control

A variable control which moves the trace vertically ±80mm.

Mode Selector

A bank of four inter-dependent push-button switches, which provide a choice of three single trace and two dual trace modes of operation.

A101 DUAL VERTICAL DEFLECTION AMPLIFIER

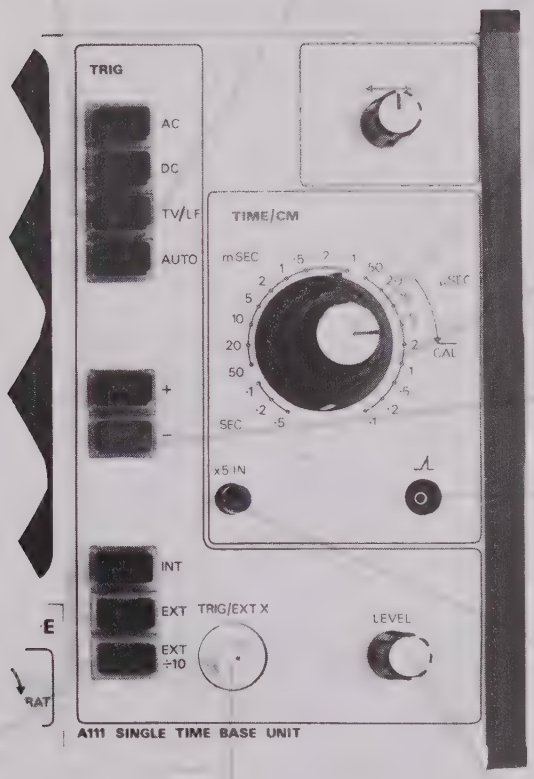
INTRODUCTION

This unit is a wideband, dual channel amplifier which provides switched, calibrated sensitivities of between 5mV/cm and 20V/cm over a bandwidth of d.c. to 30MHz. It may be operated in single, dual and additive modes. A delay line is fitted in the amplifier signal path which enables the timebase sweep to commence before the input signal is displayed.

◄CONTROLS AND CONNECTORS

Trigger (Coupling) Selectors
Three push-button switches used to select the type of coupling of the trigger or X input. Selection of any of these allows the trigger level to be set manually by use of the LEVEL control.

Trigger (Mode) Selector
A push-button switch used to select the AUTO mode of trigger operation. This mode provides steady triggering without use of the LEVEL control.



Trigger (Source) Selectors
Three push-button switches which select the trigger source and external trigger sensitivity.

TRIG/EXT X
A BNC type connector which accepts external trigger or external X inputs.

Level
A rotary control used to adjust t
triggering level, when the timeba
is operating in the AC, DC or TV/
mode. The action of the control is
hibited when AUTO mode is selecte

Shift Control

dual speed variable control which ves the trace left or right [1.1 een widths], enabling either end of trace to be centred even when ly expanded.

ne Velocity Control

variable control which may be used slow the selected timebase speed by least 2.5:1. The control has a spring ded detent at the CAL position.

eep Speed Selector

twenty-one position rotary switch d to select the timebase speed. e displayed sweep speed is accurate the selected range only when the e velocity control is set to CAL.

pe Selectors

o push-button switches which se- t triggering to occur on the +ve or slope of the trigger input.

–

2mm socket at which the timebase np signal can be monitored when sweep speed selector is set to a ebase range. With the selector set XY either internal or external trigg- ignals can be monitored.

IN (times 5 selector)

push-button switch which, when de- ssed, increases the gain of the X plifier, thus increasing the sweep ed by a factor of 5.

A111 SINGLE TIMEBASE UNIT

INTRODUCTION

The A111 is a single timebase unit which provides, switched, calibrated sweep velocities of between 0.1μsec/cm and 0.5sec/cm; the X5 IN and Fine Velocity controls extend the sweep speed to 20ns/cm and 1.25 sec/cm. The sweep may be initiated by either an internal or external trigger source.

◄CONTROLS AND CONNECTORS

B Fine Vel

A variable control which slows the B sweep speed by a factor of up to 2.5:1. The control has a detent at the fully clockwise **CAL** position.

Trigger (Coupling) Selectors

Three push-button switches used to sel ect the type of coupling of the trigger or X input. Selection of any of these allows the trigger level to be set manually by use of the LEVEL control.

Trigger (Mode) Selector

A push-button switch used to select the AUTO mode of trigger operation. This mode provides steady triggering without use of the LEVEL control.

Slope Selectors

Two push-button switches which select triggering to occur on the +ve or -ve slope of the trigger input.

X5 IN (times 5 selector)

A push-button switch which, when depressed, increases the gain of the X amplifier, thus increasing the displayed sweep speed by a factor of 5.

Trigger (Source) Selectors

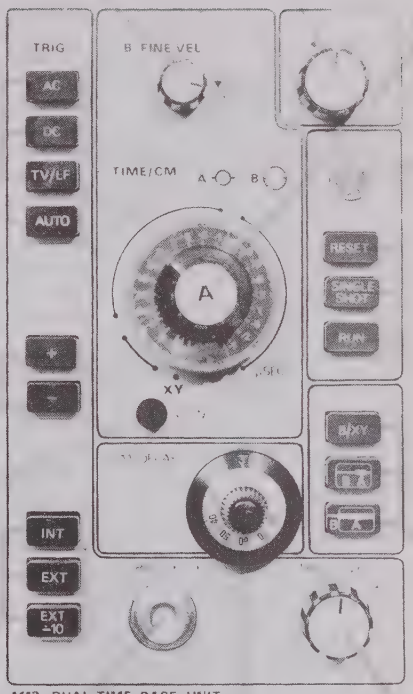
Three push-button switches which select the trigger source and external trigger sensitivity.

TRIG/EXT X

A BNC type connector which accepts external trigger or external X inputs.

X Shift Control

A dual speed variable control which moves the trace left or right (1.1 screen widths), enabling either end of the trace to be centred even when fully expanded.



A112 DUAL TIME BASE UNIT

CM Delay

A ten-turn control, whose setting determines the starting position of the A timebase strobe along the B ramp. This gives a continuously variable delay time in the B A mode.

Sweep Speed Selector.

A dual 21-position switch to select the timebase sweep rates. The inner knob controls the A timebase, its sweep rate being indicated by the position of the white line on the knob. The outer castellated transparent knob controls the B timebase; its sweep rate is indicated by the position of the white dot against the background of white figures. When used in the single timebase mode (B/XY selected), only the outer selector is effective. The B timebase calibration is only accurate when the **B Fine Velocity** control is at **CAL**.

Ready

A neon indicator lamp, which is illuminated when the timebase is ready to be fired by a trigger signal. It is only operative in the single shot mode.

Single Shot Selectors

When SINGLE SHOT is depressed, the timebase will run for one sweep only, initiated by the trigger pulse. If a further single shot is required, depressing RESET will reset the timebase, and the 'Ready' lamp will light; the next trigger pulse will fire the timebase again. Depressing RUN will restore the timebase to normal repetitive operation.

Delay Mode Selectors

The single timebase mode of operation is selected by depressing B/XY . The other two buttons give a pictorial representation of the two dual-timebase modes.

selects 'B intensified by A', and

selects 'A delayed by B'.

Trig Level

A rotary control used to adjust the triggering level, when the timebase is operating in the AC, DC, or TV/LF mode. The action of the control is inhibited when AUTO mode is selected.

A 112 DUAL TIMEBASE UNIT

INTRODUCTION

The A112 is a dual timebase unit, providing calibrated sweep and delay speeds from 100ns/cm to 0.5sec/cm. It also offers single shot timebase operation and XY plot facilities.

◄ CONTROLS AND CONNECTORS

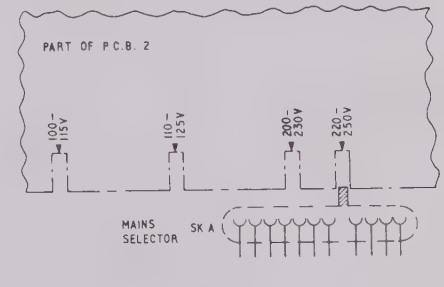
PRELIMINARY OPERATIONS

INITIAL CHECKS

The following instructions should be carried out on receipt of the instrument, before power is applied.

1. Check the setting of the mains supply selector as follows:-

   Loosen the recessed captive screw at the rear of each side cover. Slide out the two side covers and the top cover from the rear of the instrument. Check that the mains selector is in the correct position for the local supply. Replace the top cover. Replace and secure the two side covers.



2. Check that a mains supply plug is correctly connected to the cable.

2a. If necessary connect as follows:- Line to brown. Neutral to blue. Earth to Green/Yellow.

3. Check that the correct mains supply fuse is fitted [0.5A for 230V operation, 1A for 115V operation].

The oscilloscope is now ready to display a basic trace. A simple method of obtaining a trace is described in the following section, INITIAL TRACE FINDING.

INITIAL TRACE FINDING

Switch POWER on and check that the power indicator lights. If a trace is not visible after a warm-up period of approximately 30 seconds, locate the trace as follows:-

1. Set the BRILLiance, FOCUS and ASTIGmatism controls to approximately 'mid' position.

2. Set the controls on the X and Y modules as follows:-

X unit	TRIGger mode	AUTO
	TRIGger source	INT
	TRIGger coupling	AC
	Shift control	mid-position
	X5 IN	released
	TIME/CM or TIME/CM B	1m sec
	B FINE VEL	CAL
A112	Single Shot Selectors	RUN
only	Delay Mode Selectors	B

Other controls not significant

3. A trace should now be visible, if it is not carry out procedure 4.

4. Increase the brilliance to maximum then adjust the X and Y shift controls to centre the trace on the screen. Re-adjust the focus and brilliance controls to obtain optimum trace definition.

The oscilloscope is now ready for use. Before carrying out signal measurements, however, the sub-units should be calibrated as described in the USER CALIBRATION section.

USER CALIBRATION

The following user calibration procedures should be carried out at regular intervals. If an X or Y sub-unit is changed reference should be made to the technical manual for full calibration procedures.

1. If a trace is not already visible, obtain a trace as described in the preceding section, INITIAL TRACE FINDING.

2. Set the controls on the X and Y modules as follows:-

X unit	TRIGger mode	AUTO
	TRIGger source	INT
	TRIGger coupling	AC
	TRIGger slope	+
	Shift control	mid-position
	X5 IN	released
	B FINE VEL or	
	Fine velocity control	CAL
	TIME/CM or TIME/CM B	1m sec
A112	Single Shot Selectors	RUN
only	Delay Mode Selectors	B

Other controls not significant

Y Unit	Sensitivity Y1	50mV/cm
	Fine gain Y1	CAL
	Input coupling Y1	DC
	Sensitivity Y2	50mV/cm
	Fine gain Y2	CAL
	Input coupling Y2	
	- Y2 IN [Invert Y2]	released
	Mode	Y1
	Trigger	Y1

3. Connect a lead from the 0.3V cal. socket to the Y1 input connector. A square wave signal should now be displayed on the screen. Check that one cycle of the square wave occupies exactly 1cm on the horizontal axis.

4. Adjust the Y1 shift control to position the top edge of the square wave one centimetre from the top of the graticule. If necessary, re-adjust the BRILLiance, FOCUS and ASTIGmatism controls to obtain optimum trace definition.

5. Adjust the Y1 CAL preset control to set the amplitude of the square wave to exactly 6cm peak to peak.

6. On the Y unit, set the mode selector and the trigger selector to Y2.

7. Transfer the input signal from Y1 to Y2. Set the Y1 input coupling selector to and the Y2 selector to DC. Adjust the Y2 shift control to position the top edge of the square wave one centimetre from the top of the graticule.

8. Adjust the Y2 CAL preset control to set the amplitude of the square wave to exactly 6cm peak to peak. Remove the input lead.

9. Set the Y2 sensitivity selector to 20mV/cm and adjust the Y2 shift control to centre the trace on the screen.

10. Set the sensitivity selector to 50mV/cm and check that the trace is still in position on the centre line. If it is not, adjust the BAL. preset control to re-centre it.

11. Repeat procedures 9 and 10 until the trace remains in position when the Y2 sensitivity selector is switched between 20mV/cm and 50mV/cm.

12. Set the Y1 sensitivity selector to 20mV/cm and adjust the Y1 shift control to centre the trace on the screen.

13. Repeat procedure 10 and 12 until the trace remains in position when the Y1 sensitivity selector is switched between 20mV/cm and 50mV/cm.

The preceding information together with the published specification should enable the experienced user of oscilloscopes to use the A100 to its full capabilities. The following operating procedures, which are in the form of application notes, are provided mainly for the less experienced user. In places the procedures refer to the basic principles of oscilloscope use and describe how these principles may be applied to the A100.

Although the X and Y modules are used simultaneously their respective functions may be considered separately. Therefore, the following operating procedures are divided into separate sections. The first section describes the operation of the Ymodule and the second the operation of the X modules.

The sections are composed of various practical examples, each of which describes a particular method of operation. Each example gives a diagram of a typical trace waveform and a list of control settings which may have been used to obtain that waveform. After the control settings there is a description of the way in which the display may be interpreted.

NORMAL OPERATING PROCEDURES

A101 DUAL VERTICAL DEFLECTION AMPLIFIER

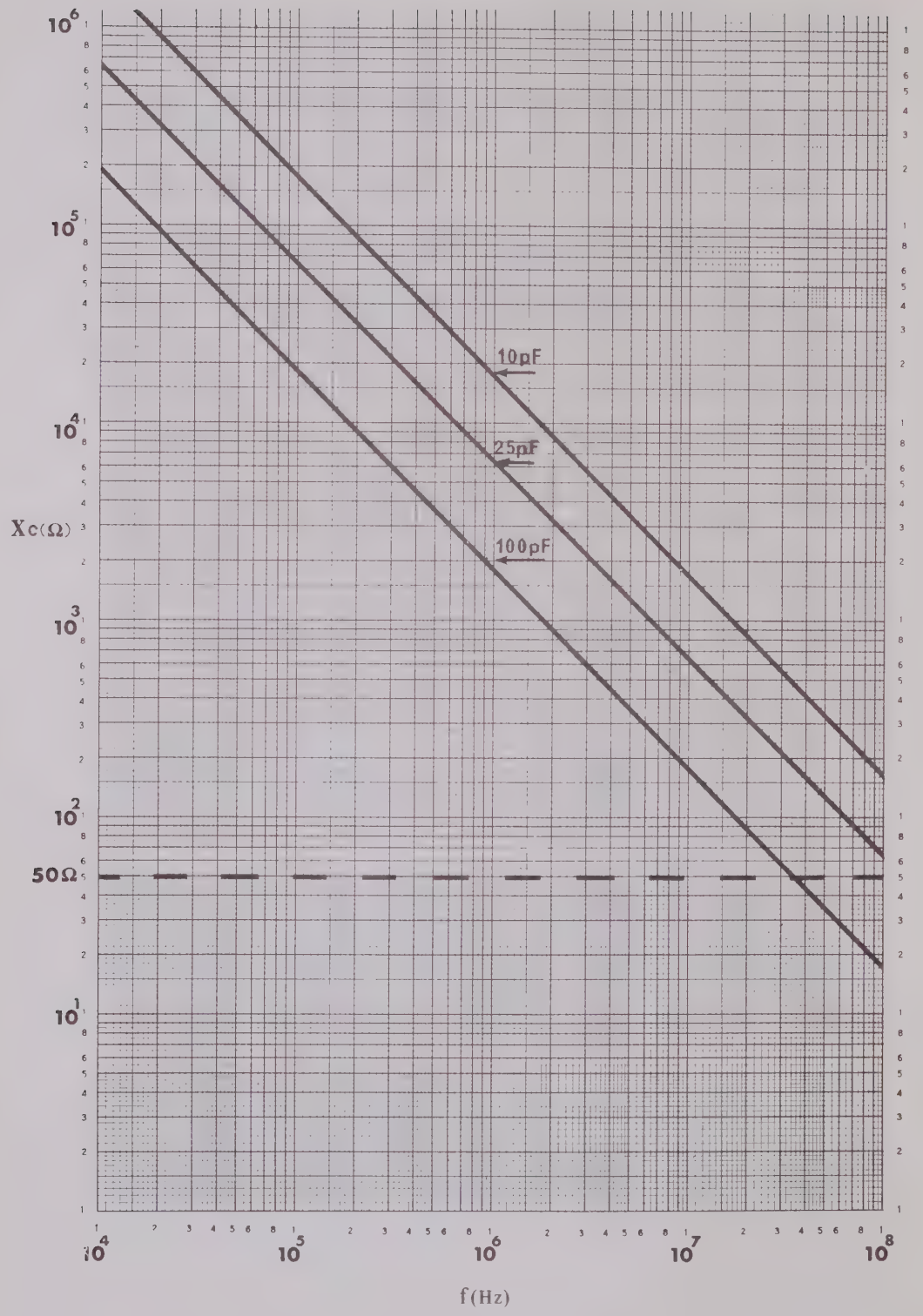
INPUT CONNECTIONS

It is important that suitable connecting leads are used to the Y inputs. Unscreened connections should be used only for low frequency, high level signals as considerable interference may be picked up on this type of cable. A screened co-axial cable will be essential on most applications.

The capacitance of this cable [typically 20 pF/ft] naturally adds to the input capacitance of the oscilloscope. Thus the basic 25pF input capacitance of the A101 will be increased to nearly 90pF when used with a typical 1 metre co-axial input lead. This capacitive loading corresponds to a shunt reactance of about 200Ω at 10MHz or about 70Ω at 30MHz. Thus for all high frequency applications the 1MΩ input resistance is of no practical significance: it is the effect of capacitive loading which will severely attenuate HF signals. Except where frequencies and/or circuit impedances are really low, it is essential to employ a probe if meaningful displays are to be achieved. For example, even on a 100kHz sine wave signal from a 10kΩ source an error of approximately −35% would result on amplitude measurement due to the loading of the oscilloscope and its connecting lead. It is the capacitive loading which is responsible for this loss: with a 1MHz signal under similar conditions the resulting display would be only about one-sixth of the true value.

It will be appreciated that the attenuation is proportional to frequency, thus a pulse or complex waveform may appear very distorted due to the more severe attenuation of its HF components. The oscilloscope input circuit is acting as a low pass filter: i.e. pulses will suffer rounding of their edges. One must not only consider the misleading display under these conditions but the virtual certainty of an adverse effect on the circuit under test. The Reactance-Frequency chart shows the effect of reactance loading over a wide range of frequencies for different input capacitances: likely loading errors can then be estimated if the source resistance is known.

Many high frequency and pulse generators have a source resistance of 50Ω and in these cases it is usually desireable to operate into a matched load i.e. with a terminating resistor [50Ω pad] across the oscilloscope input. This will minimise reflections from the



Reactance/Frequency Chart

oscilloscope input circuit and hence standing waves on the connecting cable. Correct termination, which will halve the open circuit source voltage, is essential when checking the bandwidth of the instrument.

In many circuit applications where a terminating pad cannot be used the severe capacitive loading cannot be tolerated. The most satisfactory method of connection is then via a compensated probe, such as the CX3500. This passive probe introduces an attenuation of 10:1 which must obviously be allowed for when making measurements. It increases the input resistance presented to the circuit under test to 10MΩ and reduces the effective capacitance to approximately 11pF. The full bandwidth of the Y amplifier is maintained when using the CX3500. It is very important that the compensation on a probe is correctly adjusted to ensure that all frequencies are attenuated equally. The necessary procedure is outlined in "The CX3500 Probe-Operation" in section 6 of this Manual. More detailed information is provided in the CX3500 Technical Manual.

An active probe may be used when the attenuation introduced by a passive probe is not acceptable.

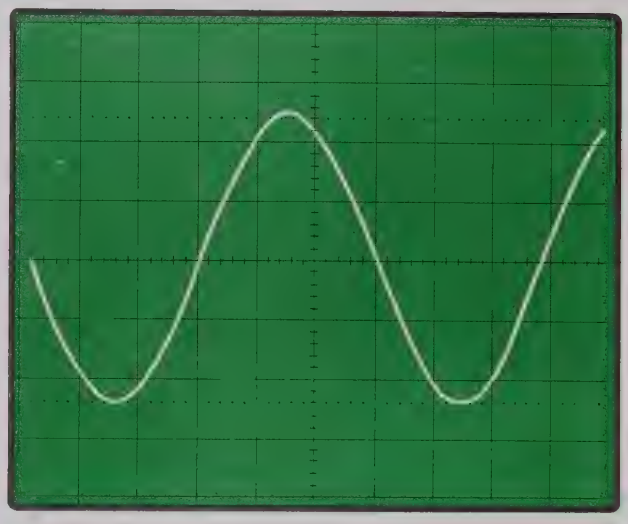
TRIGGERING

Although triggering is a function of the X unit, the initial trigger signal is originated in the Y unit when internal triggering is selected. The display signal output from the Y pre-amplifier unit is routed to the Y deflection amplifier via a delay line, whereas the trigger signal output to the X unit for triggering [or XY plot] is routed directly. This allows the timebase to start its sweep before the vertical deflection begins, thereby enabling the leading edge of a fast pulse to be displayed.

The timebase will not synchronize without a suitable trigger signal. Therefore, the minimum vertical deflection that can be displayed is determined by the trigger characteristics of the X unit.

The following examples describe the operation of the Y module with various mode selections.

SINGLE TRACE (A.C.)



Control Settings

Sensitivity Y1	0.2V/cm
Sensitivity Y2	-
Coupling Y1	AC
Coupling Y2	-
Mode	Y1
Invert Y2	released
Trigger	Y1

Signal applied to Y1 input

Interpretation

This is the method used to measure an a.c. voltage. Measurement is made in the normal way i.e. in this example the deflection is 4.9cm, peak to peak and the selected sensitivity is 0.2V/cm. Therefore, the trace represents an input voltage of 4.9 x 0.2 = 0.98V peak to peak or 0.349V r.m.s. [i.e. $\frac{V_{p-p}}{2\sqrt{2}}$]

Although A.C. coupling is used in the example illustrated, D.C. coupling can also be used, providing that the d.c. level with respect to a.c. is not excessive, i.e. providing that the d.c. level is not more than approximately 1.5 times the full screen deflection voltage. D.C. coupling should always be used below 3Hz.

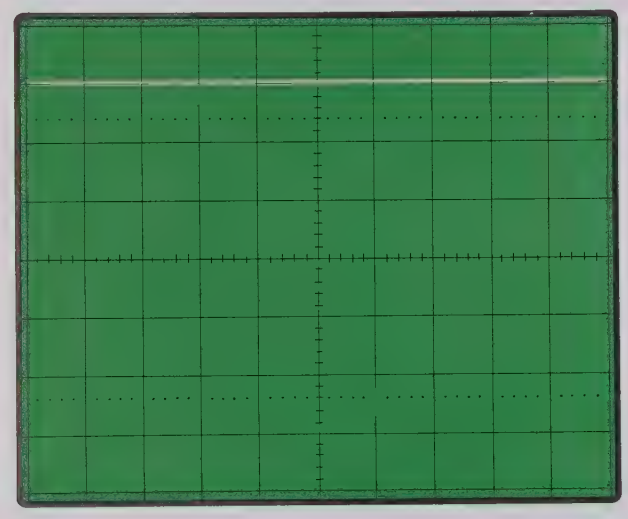
Any voltage between approximately 1mV and 160V [peak to peak] may be measured in this way up to a frequency of 30MHz, with the following qualifications:

1. The input connections to the Y unit must be suitable for the frequency and impedance of the circuit being measured.

2. All measurements must take into account the characteristics of the connecting leads or probes in use.

3. Readings taken at the upper bandwidth limit must be corrected to allow for frequency 'roll off' [i.e. at 30MHz the true value of a displayed sine wave will be:- Vp-p x $\sqrt{2}$].

SINGLE TRACE D.C. (SETTING D.C. ZERO)



Control Settings

Sensitivity Y1	-
Sensitivity Y2	-
Coupling Y1	
Coupling Y2	
Mode	-
Trigger	-
Trig Mode [X unit]	Auto [See page 4.11]

Interpretation

Before measuring a d.c. level it is necessary to establish the zero level. This example illustrates the method.

The position of the trace represents zero volts. It can be positioned anywhere on the screen by use of the shift control.

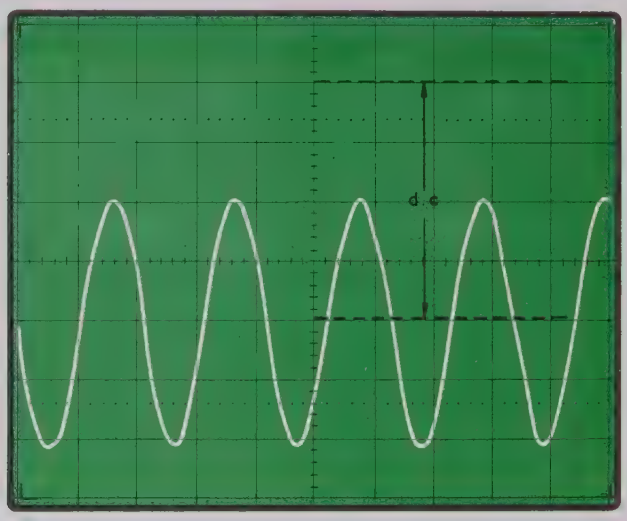
If the expected d.c. level is more negative than the a.c. peak value, the trace should be at the top of the screen. If the d.c. level is expected to be more positive, then the trace should be at the bottom of the screen.

Once the zero position has been established the shift control must not be moved again before the d.c. measurements have been taken.

The AUTO trigger mode must be selected on the X sub-unit, in order to obtain the d.c. zero trace.

NOTE: It may sometimes be found helpful, when measuring d.c. levels, to use the Y2 trace as a zero d.c. reference point. This may be easily achieved by simply setting the Y2 trace to the same position as the Y1, in the manner already described for Y1. The input signal can now be displayed on the Y1 trace, leaving Y2 as a constantly displayed reference point.

SINGLE TRACE D.C. (MEASUREMENT)



Control Settings

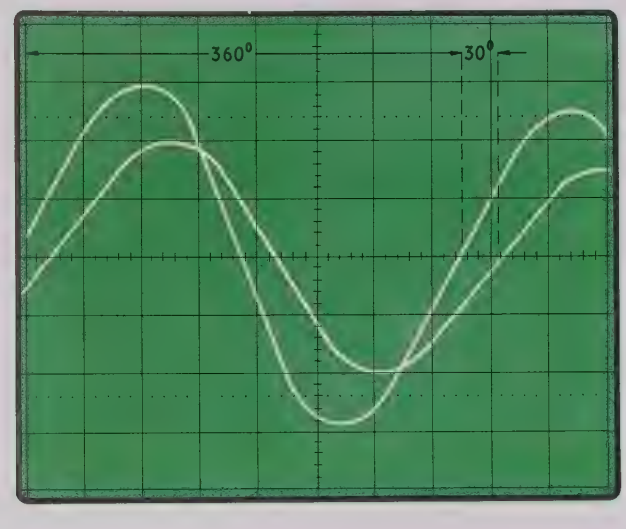
Sensitivity Y1	0.5V/cm
Sensitivity Y2	-
Coupling Y1	DC
Coupling Y2	
Mode	Y1
Invert Y2	released
Trigger	Y1

Signal applied to Y1 input

Interpretation

The d.c. level is measured between the mean level of the a.c. and the zero d.c. reference point. In the example illustrated the d.c. deflection is 4.0cm. Therefore, the value of the d.c. signal level is 4.0 x 0.5 = 2.0V d.c.

DUAL TRACE



Control Settings

Sensitivity Y1	0.5V/cm
Sensitivity Y2	1V/cm
Coupling Y1	AC
Coupling Y2	AC
Mode	ALTernate [or CH'P]
Invert Y2	released
Trigger	Y1 [or Y2]

Signals applied to Y1 and Y2 inputs.

Measurements

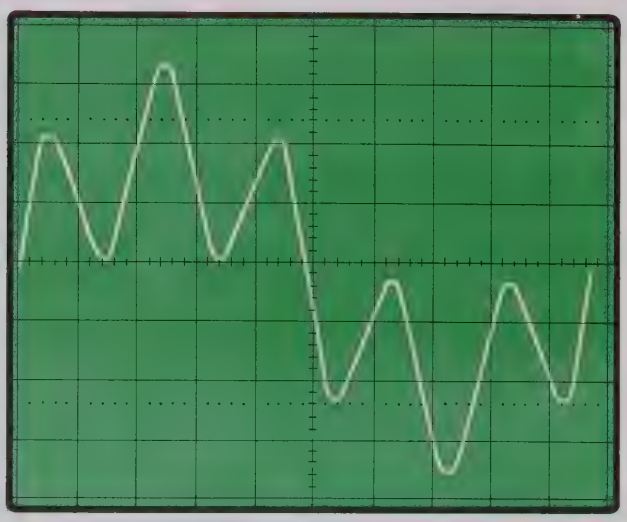
Y1, 5.5 x 0.5 = 2.75V [0.943V r.m.s.]
Y2, 3.8 x 1 = 3.8V [1.35V r.m.s.]
Phase angle 30 degrees.

The choice of mode [ALT or CHOP] depends mainly on the sweep speed selected on the X sub-unit. In general, ALT mode should be used on fast sweep speeds and the CHOP mode should be used on slow sweep speeds. Over a wide range of speeds, however, the choice will be arbitrary, in which case the ALT mode of operation is preferable.

The dual trace facility may be used with d.c. coupling for comparison of d.c. levels.

The choice of trigger [Y1 or Y2] depends on which trace is being used as a reference. If possible, the channel which is operating on the lowest frequency should be used to provide the trigger.

SINGLE TRACE ADDED (Y1 + Y2)



Control Settings

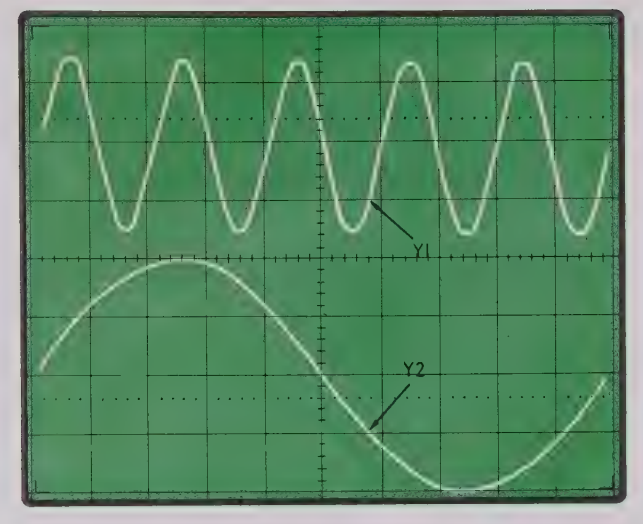
Sensitivity Y1	1V/cm
Sensitivity Y2	1V/cm
Coupling Y1	AC
Coupling Y2	AC
Mode	Y1 + Y2
Invert Y2	released
Trigger	Y1 and Y2 [MIX]

Signals applied to Y1 and Y2 inputs.

Measurements 6.8V (peak to peak)

This mode of operation is used to display the composite waveform which results from the addition of two inputs. If the two inputs are displayed separately in the dual trace mode and the mode is then changed to Y1 + Y2 the effect of the addition and the resulting peak value can be ascertained.

In the example illustrated above, the trace is composed of the two components, Y1 and Y2, shown in the illustration on the following page.



SINGLE TRACE ADDED (Y1 - Y2)

The control selections for this mode of operation are exactly the same as those for Y1 + Y2 except that in this mode the −Y2 IN switch must be pressed.

This mode is often used as a differential amplifier, where the trace represents the difference between the Y1 and Y2 input signals. If this mode of operation is required, the outputs of the two amplifiers [Y1 and Y2] should be balanced as follows:-

Apply the same signal to the inputs of Y1 and Y2 simultaneously. Set both channels to the maximum, practicable, sensitivity [see next paragraph]. If a signal of more than a few mm is displayed, the amplifiers should be re-calibrated as described in the appropriate setting up instructions contained in the preceding sections of this manual. If the displayed signal is less than a few mm then it is a common mode voltage and should be eliminated by means of one of the variable fine gain controls.

Before this mode of operation is used, it is important to check that the individual signals do not overdrive the amplifiers. This check should be made by switching to dual trace and ensuring that neither trace greatly exceeds full screen amplitude at the sensitivity in use.

A111 SINGLE TIMEBASE UNIT

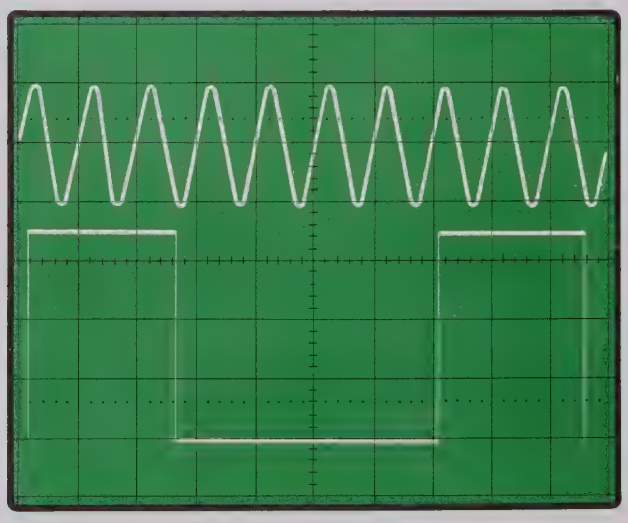
TRIGGERING

The A111 timebase unit requires the application of a recognisable trigger signal to initiate its sweep. If this signal is not received, the sweep will not commence and it will therefore be impossible to display a waveform. The choice of trigger source, either internal or external, depends mainly on the type of input signal.

The trigger system on the A100 oscilloscope has two basic modes of operation, level control and AUTO. The trigger operates in the level control mode whenever trigger coupling is selected [AC, DC or TV/LF] and in this mode the trigger level can be set by use of the LEVEL control. When AUTO is selected, the level mode of operation is inhibited and the trigger level is referred to the mean level of the input signal. If trigger coupling is subsequently selected the AUTO mode will be cancelled and the trigger operation returned to the level control mode.

The following examples describe the operation of the X sub-unit when used with various trigger selections.

AUTO TRIGGERING



Control Settings

Sweep speed	0.2ms/cm
Trigger mode	Auto
Trigger slope	X
x5 IN	released
Trigger source	INT
TRIG [Y unit]	Y2

Signals applied to Y1 and Y2 inputs.

Measurements

[Y1] Period = 1 x 0.2ms = 0.0002s

$$f = \frac{1}{0.0002} = 5\text{kHz}$$

[Y2] Period = 7 x 0.2ms = 0.0014s

$$\text{p.r.f.} = \frac{1}{0.0014} = 714\text{Hz}$$

This example explains basic time measurement and its relationship to frequency and pulse repetition frequency. The maximum sweep speed that can be obtained is 20ns/cm [0.1μs/cm selected and x5 pressed] enabling a 50MHz signal to be displayed at 1 cycle per cm.

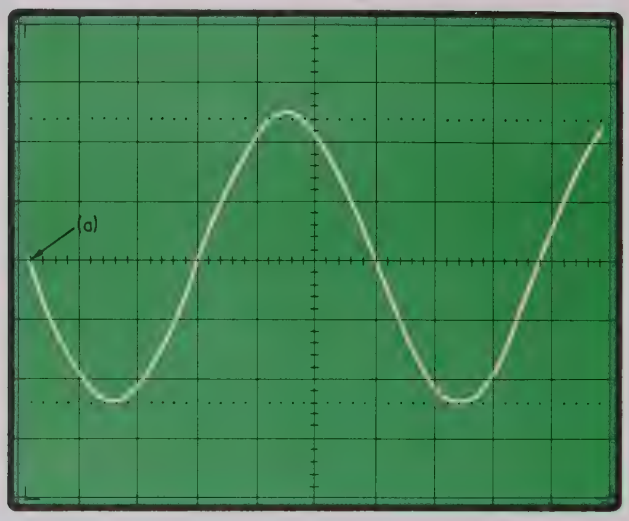
The Y2 channel provides the triggering signal by routing its pulse input to the X sub-unit [Y2 and INT trigger selected]. Although the pulse is acting as the trigger, the whole of the pulse is displayed due to the built-in, signal, delay in the Y sub-unit.

With AUTO selected the trigger level is at or near the mean level of the waveform. If no trigger signal is applied, the timebase will 'free run'. The timebase repetition frequency is then normally 40Hz at speeds below 20μs/cm and 3kHz at 10μs/cm and above. Thus a bright base-line is provided at all sweep speeds in the absence of a trigger signal.

Due to the 'free-running' arrangement on AUTO, difficulty may occur in obtaining steady triggering with small amplitude input signals of lower frequency than the timebase se repetition frequency. This effect may be overcome, however, by increasing the amplitude ude of the input signal. Under these circumstances steady triggering can be achieved at frequencies considerably below the timebase repetition frequency. Triggering difficulty may also be experienced in this mode with input signals which have high mark-space ratios. atios.

If satisfactory triggering cannot be achieved with AUTO selected, select AC or DC coupling, as appropriate, and adjust the LEVEL control. Steady triggering will now be achieved.

NORMAL TRIGGERING (LEVEL CONTROLLED)



Control Settings

Sweep speed	1ms/cm
Trigger slope	-ve
x5 IN	released
Trigger coupling	AC
Trigger source	INT
TRIG [Y unit]	Y1

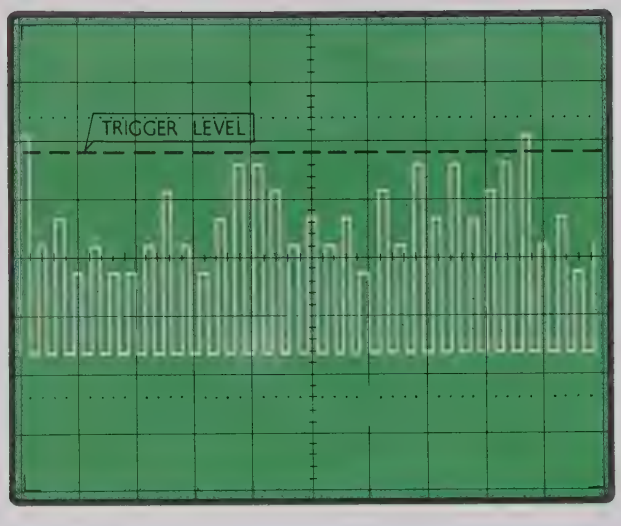
Signal applied to Y1 input.

NOTE: The trigger operates in the level control mode whenever AC, DC or TV/LF, trigger, coupling is selected.

In this example the trigger point is on the negative slope, at point [a]. The trigger point can, however, be positioned anywhere on the negative slope by use of the LEVEL control.

If +ve slope is selected triggering will occur on the positive slope, at a point determined by the setting of the LEVEL control.

PULSE TRIGGERING



Control Settings

Sweep speed	1ms/cm
Trigger slope	-ve
x5 IN	released
Trigger coupling	DC
Trigger source	INT
Trigger [Y unit]	Y1

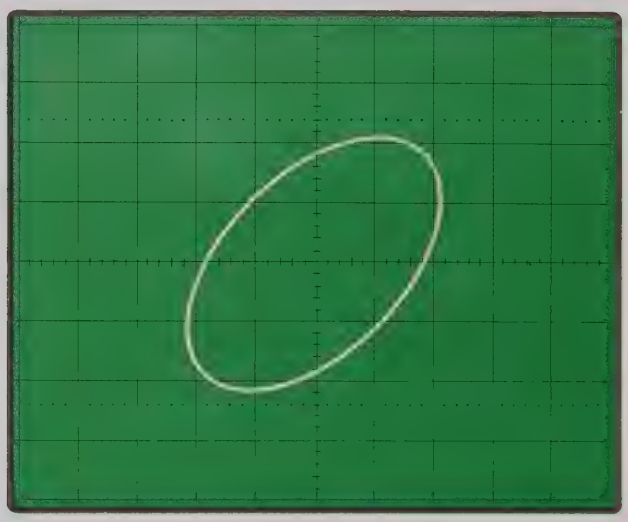
Signal applied to Y1 input

Interpretation

This example illustrates the type of triggering necessary for the display of an uneven pulse train. The figure shows a multilevel pulse train which is repetitive every 28 pulses. In order to display a steady trace, triggering must occur on only one recognisable pulse in each 28. In this case one pulse is easily recognisable by its amplitude. The trigger level should therefore be set to the level shown.

With this type of input signal it is only possible to use internal triggering if one of the pulses is recognisable by its amplitude. If this is not possible it may be desirable to use the external trigger input. For instance it may be possible to use a clock pulse associated with the signal as a trigger input, in which case EXT or EXT divided by 10 should be selected and the clock pulse connected to the TRIG/EXT X input.

XY PLOTTING



Control Settings

Y Unit		X Unit	
Sensitivity Y1	0.5V/cm	TIME/CM	XY
Sensitivity Y2	0.5V/cm	Trig. coupling	DC
Coupling Y1	DC	Trig. source	INT
Coupling Y2	DC	X shift	central
Mode	Y2	Single shot [A112]	RUN
TRIG	Y1	Other controls ineffective	
X10 IN	released		
-Y2 IN	released		

Interpretation

The trace above shows an XY plot of two equal-amplitude sine waves [2V peak-peak]; one is phase-shifted relative to the other. To measure this phase angle, the ellipse must first be centred vertically about a horizontal graticule line. Next, the maximum horizontal width, D1, is measured [4.3cm above], and then the distance, D2, between the points where the ellipse cuts the X axis [3.6cm above]. The phase angle, θ, is given by the relationship

$$\theta = \text{Sin}^{-1} \frac{D2}{D1}$$

The measurements above result in a phase angle of 57^{o}.

The A100 is particulary versatile when used in the XY mode. The various alternatives are best described in tabular form, as follows.

The Y attenuator settings and coupling controls depend on the individual application, though it is stressed that DC coupling should be used wherever possible, to avoid phase shift at low frequencies. Use of the Y1 X 10 amplifier gives AC coupling.

Requirement	Control Settings		Signal Inputs	Remarks
	Y	X		
Invert Y capability	Mode Y2 Trig Y1	Time/cm XY Trig source INT X shift central	Vertical Y2 Horizontal Y1	Press -Y2 to invert vertical signal
Maximum sensitivity horizontal and vertical	Mode Y1 Trig Y2 Press Y1 x 10	Time/cm XY X shift central Trig source INT Press x5	Vertical Y1 Horizontal Y2	Maximum sensitivity Vertical 500μV/cm Horizontal 1mV/cm
Maximum horizontal sensitivity	Mode Y2 Trig Y1 Press Y1 x 10	Time/cm XY X shift central Trig source INT Press x5	Vertical Y2 Horizontal Y1	Maximum horizontal Sensitivity 100μV/cm
Two individual Y signals against X	Mode CHOP Trig -	Time/cm XY X shift as required Trig source and x5 - see below	Vertical to Y1 and Y2 Horizontal to EXT X	Horizontal sensitivities see below Y2 may be inverted by pressing -Y2.
Agebraically added Y1 and Y2 signals against X	Mode Y1 and Y2	Time/cm XY X shift as required Trig source and x5 - see below	Vertical to Y1 and Y2 Horizontal to EXT X	Horizontal sensitivities See below For Y differential mode, press -Y2.

Sensitivity

When used in the first three modes, a full range of horizontal sensitivities is available, as indicated on the appropriate Y attenuator. When used in the other two modes, four horizontal sensitivities are available - 100mV/cm, 500mV/cm, 1V/cm and 5V/cm, depending on the setting of the Trig Source and x5 IN selectors. Settings are tabulated below.

Sensitivity	Trig Source	x5 IN button
100 mV/cm	EXT	pressed
500 mV/cm	EXT	released
1V/cm	EXT ÷ 10	pressed
5V/cm	EXT ÷ 10	released.

Phase Shift

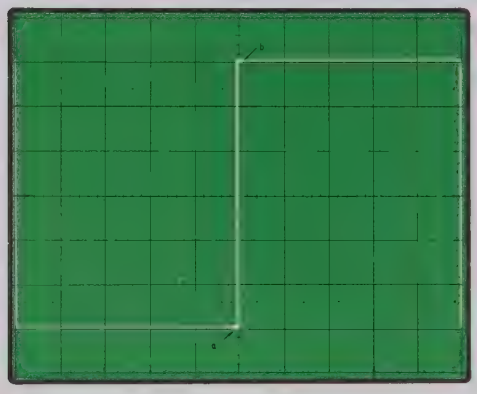
The horizontal bandwidth for full-screen deflection is typically 3MHz to the 3db down point, at which the phase shift is approximately 45 degrees. The latter stages of the Y amplifier contain the Y delay line, which gives a vertical signal phase shift of approximately 45 degrees at 1MHz; the frequency/phase shift relationship remains constant up to 20MHz.

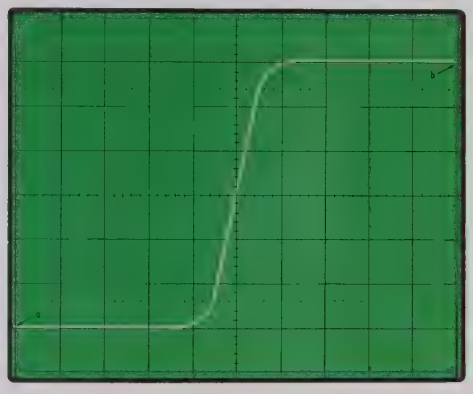
A112 Dual Timebase Unit

The applications given for the A111 single timebase unit are valid for the A112 when the Single Shot Selectors are set to RUN and the Delay Mode Selectors to B/XY

The remainder of the circuitry is concerned with the delayed sweep and single shot modes.

DELAYED SWEEP MODE





Control Settings

Trigger mode	AUTO
Trigger source	INT
Trigger coupling	AC
Trigger slope	–
X5 IN	released
B FINE VEL	CAL
TIME/CM B	1ms
TIME/CM A	20μs
CM DELAY	4.95
Single Shot Selectors	RUN
Delay Mode Selectors	B A

To obtain this trace, select B A

Interpretation

The basic sweep rate is the B timebase. The figures on the CM DELAY dial indicate that the A timebase will commence to run 4.95cm after the start of the B timebase. Therefore, with the settings shown, the A timebase start has been delayed until 4.95mS after the trigger pulse.

The main purpose of this system is to examine in detail a small section of a waveform. An obvious example is the rise-time of a rectangular pulse, as illustrated above.

The left-hand trace illustrates the single timebase mode of operation, except that there is a

brightened section of the trace, which indicates that the A timebase is running for that period. Examination of the control settings will show that the A timebase runs 50 times as fast as the B timebase, so that if the brightened section of the trace can be made to fill the screen, this will be equivalent to a X50 expansion of the B sweep trace. This is achieved by switching to the "A delayed by B" mode [button B A pressed]. If the CM DELAY control calibration is exact, the waveform illustrated in the right hand picture will now appear.

In practice, it is seldom possible to obtain exact calibration of the CM DELAY control [or delay time multiplier, as it is sometimes called], and the rising portion of the waveform may not be in the centre. It may be off the screen altogether, in which case, slight re-adjustment of the CM DELAY control is necessary. The likelihood of this condition occurring depends to a large extent on the ratio of the two timebase speeds.

When large ratios of timebase speed are in use, two effects will be noticed.

1. The brightness of the trace will be reduced. This is because of the low repetition rate duty cycle. It can be remedied to a certain extent by adjustment of the brilliance control, but care must be taken to ensure that the brilliance control is reduced before switching back to the B A mode otherwise the CRT phosphor may be damaged.

2. There may be a degree of jitter on the displayed trace, due to slight irregularities in the comparator level. The only remedy for this is to reduce the sweep speed ratio. The maximum jitter ratio is given in the module's specification.

SINGLE SHOT

This facility is usually used in conjunction with a camera, or for observing non-repetitive traces, in which case the use of a viewing hood is recommended.

Selecting SINGLE SHOT inhibits the trigger action of the timebase and the screen will remain blank [after completing any sweep in progress on selection].

Depressing RESET will prime the circuit, ready for a single sweep to take place; the READY light will be lit indicating that the circuit is primed.

The next trigger pulse after the circuit is primed will cause a single sweep of the timebase, and extinguish the READY light.

When using a camera, if the trigger pulses are sufficiently infrequent or if the trigger is under control of the operator, the shutter should be opened after the READY light is lit and closed when the sweep is completed. If, on the other hand, the trigger pulses are of high frequency, the shutter should be opened before selecting RESET.

TELEVISION SIGNAL

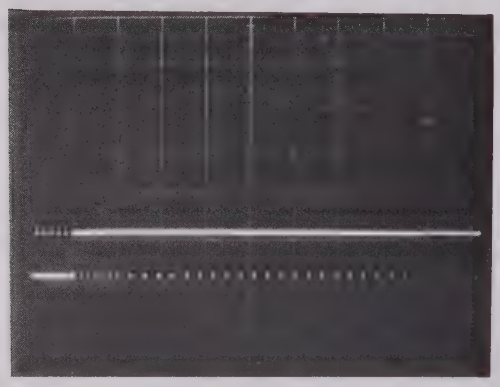
Control Settings

Y Unit [All traces]	Y2 sensitivity	0.2V/cm
	Y2 coupling	DC
	MODE	Y2
	TRIG	Y2
	-Y2 IN	released

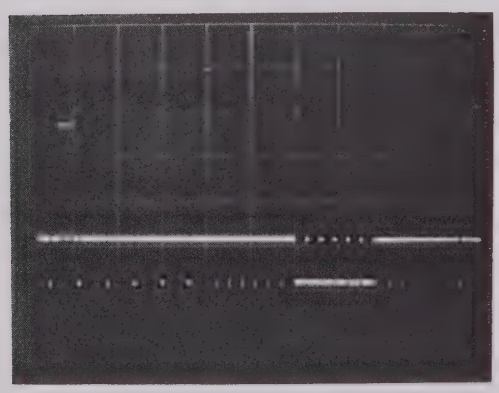
X Unit [All traces]	Trig. coupling	TV/LF
	Trig. polarity	-ve
	Trig. source	INT
	Single shot selectors	RUN

Trig. level adjusted for stable trace.

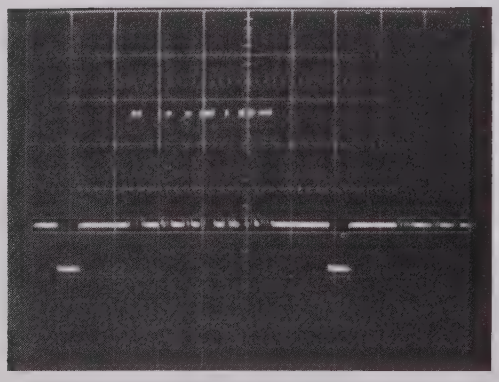
Signal applied to Y2 input



X Unit [A111 or A112]	TIME/cm or TIME/cm B	0.2ms
	Fine velocity or B FINE VEL	CAL
	Delay mode	B



X Unit [A112 only]	TIME/cm B	2ms
	TIME/cm A	0.1ms
	B FINE VEL	CAL
	Delay mode	B A
	CM DELAY	9.90



X Unit [A112 only]	TIME/cm B	0.1ms
	TIME/cm A	10μs
	Delay mode	B A
	CM DELAY	9.90

Adjust B FINE VEL to place first period of line information on the bright strobe at 9.9cm. Then select B A and this trace will appear.

Introduction

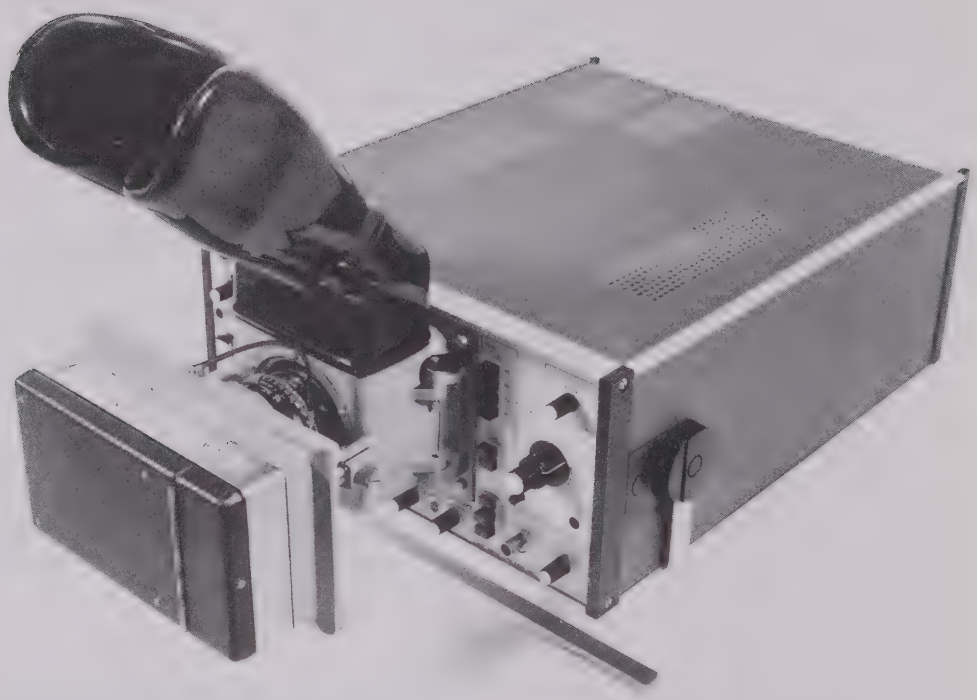
The TV/LF trigger coupling selector allows the trigger input circuit of the timebase to recognise television frame sync. pulses and reject line sync. pulses, which are of the same amplitude but of shorter duration. Thus, it is possible to display a complete frame, or the start of a frame, as shown in the first trace opposite. The X5 expansion switch allows more detailed examination, but if the A112 is in use, any part of the frame may be examined at any desired expansion, subject to the limitation of trace brightness; the middle and lower traces opposite show how this may be achieved. The traces were obtained from a digitally generated signal, thus they do not correspond exactly to a broadcast signal, but they are sufficient to allow recognition of the component parts of a composite video waveform.

The trace opposite shows the frame sync. pulse [which also contains half-line pulses to ensure that the line oscillator stays in lock], followed by the post field sync. equalisation pulses, the inter-frame blanking, and the start of the line information section.

The trace opposite shows the end of the line information section, five blank lines, pre-field sync. equalisation pulses, and then the next frame sync. pulse, after which the waveform will be as above. This trace necessitates the use of a delayed timebase, hence the A112 is required.

The trace opposite shows a line expanded for examination. The frame sync. pulse triggers the B timebase, which runs until the start of the section to be displayed, at which time the A timebase is triggered, and the waveform opposite is displayed [for a full explanation of dual timebase operation, see page 4.16]. As the waveform was digitally generated, the front and back porches of the line sync. pulse [line blanking] are not displayed.

TRACE PHOTOGRAPHY



The camera recommended for use with the A100 is the "Shackman Super Seven Mk II". Full details are given in the handbook supplied with the camera.

To fit the camera, remove the black insert from the escutcheon assembly; this will reveal four blue-headed screws. Undo the screws and lift off the white escutcheon surround. Fit the camera mounting adaptor, type A26, using the existing blue-headed screws.

The required aperture and exposure settings depend on a number of variables, including the film speed, trace brilliance and graticule illumination. Optimum settings are best determined by taking trial photographs. As a general guide, the photographs on page 4.18 were taken using 3000 ASA Polaroid film type 107, at F5.6 for 0.5 second. The brilliance control was set for a trace slightly below normal brilliance, and the graticule illumination control at about 75% rotation. It should be borne in mind that the graticule lines are coloured red, thus slightly more illumination is required than for internal-graticule CRT faces.

SPECIFICATIONS

A100 MAIN FRAME UNIT

Cathode Ray Tube

Type:	Mullard [Phillips] Type D14-121-GH, single gun, rectangular.
EHT:	10kV
Display Area:	80mm x 100mm
Graticule:	Deposited on a perspex screen mounted in front of the tube face. Graduated in 10mm squares, 2mm divisions on major axes. Dotted lines at 10% and 90% of centre 60mm. Variable illumination.
Phosphor:	Standard fitting — GH[P31] [Green, medium-short persistence]. Also available — GM[P7] [Yellowish-green, long persistence]. P39 [Green, medium-long persistence].

Calibrator

Frequency:	1kHz $\pm$1%, square wave
Rise time:	<100ns [+ve edge], <200ns [-ve edge]
Voltage Reference:	30mV $\pm$3% and 300mV $\pm$1%, peak to peak

Power Requirements

Supply Voltage:	110-125V or 200-250V
Frequency:	48Hz to 450Hz
Power:	80VA [with X and Y sub-units fitted], at 240V, 50Hz.
Protection:	0.5A mains fuse [1A for 115V operation].

Dimensions

Height:	177.8mm [7 in]
Width:	356.6mm [14in]
Depth:	419.1mm [16.5in]

Operating Temperature

$0^{o}C$ to $50^{o}C$

Storage Temperature

$-30^{o}C$ to $+70^{o}C$

A101 DUAL VERTICAL DEFLECTION AMPLIFIER

The following specification applies to the amplifiers when used in conjunction with the A100 main frame unit. The specification for both amplifiers [Y1 and Y2] is identical except that Y2 can be inverted and Y1 has an additional x10 gain position to give 500μV/cm sensitivity at a bandwidth of 5Hz to 1.5MHz.

Bandwidth (-3dB)

For full screen deflection on all calibrated ranges.

d.c. coupled:	d.c. to 30MHz
a.c. coupled:	3Hz to 30MHz

Sensitivity

5mV/cm to 20V/cm in 12 calibrated ranges, switched in 1, 2, 5 sequence, reducing to approximately 50V/cm by use of the fine gain control.

Operating Modes

1] Y1 only
2] Y2 only
3] Y1 + Y2 [by simultaneous selection of Y1 and Y2]
4] Y1 - Y2 [by simultaneous selection of Y1 and Y2, with Y2 inverted]
5] Y1 and Y2 alternately
6] Y1 and Y2 chopped [at approximately 200kHz]

Input Impedance

1MΩ ± 1% in parallel with 25pF on all ranges

Maximum Input

400V [d.c. + a.c. peak]

Measuring Accuracy

±5% [over the full Operating Temperature range].

Coupling

D.C. Earth, A.C.

Rise Time

< 12ns [10% to 90% on all calibrated ranges]

Shift
±80mm approximately

Visible Signal Delay
30ns

Dimensions

Height:	162mm [6.375in]
Width:	93mm [3.625in]
Depth:	277mm [10.9in]

A111 SINGLE TIMEBASE UNIT

Sweep Range
0.1μs/cm to 0.5s/cm in 21 calibrated ranges, switched in 1, 2, 5 sequence. The sweep range may be extended to 1.25s/cm by use of the fine velocity control and to 20ns/cm by use of the x5 selector.

Accuracy
±5% [0.1μs/cm to 0.2s/cm], ±10% [0.5s/cm]

Linearity
Within 1% on all ranges

X Shift
Either end of the trace may be displayed with full expansion.

X Expansion
x5 ±2% on all ranges

External X
Bandwidth [-3dB]

d.c. coupled:	d.c. to 8MHz [up to 4cm deflection]
a.c. coupled:	10Hz to 8MHz [up to 4cm deflection]

Full screen deflection up to 3MHz

Sensitivity

External:	100mV/cm [with x5 expansion]
	500mV/cm [without x5 expansion]
External ÷ 10:	5V/cm

Impedance (Trig/Ext X)
1MΩ in parallel with 35pF on all ranges except TV[TV 100kΩ].

Maximum Input
400V [d.c. + a.c. peak]

Trigger Source
Internal
External [via front panel BNC type connector]
External ÷ 10 [via front panel BNC type connector]

These inputs may also be used as the X source on XY plot.

Internal Trigger Sensitivity

AC or DC selected:	2mm [d.c. to 10MHz] 5mm [at 30MHz]
TV/LF selected for use as LF filter:	2mm [20Hz to 1kHz]
TV/LF selected for frame pulse triggering:	Sync pulse height >1.5cm

External Trigger Sensitivity
100mV [d.c. to 10MHz]
250mV [at 30MHz]
500mV [at 50MHz]

Trigger Selection

Auto:	This mode presents a stable trace without use of the level control. With no signal input a continual base line is displayed.
AC or DC coupled:	The trigger operating point may be altered by use of the LEVEL control.
TV/LF coupled:	This selection may be used to provide stable triggering from the frame pulses of a television signal. It may also be used as an LF filter.

Dimensions

Height:	162mm [6.375in]
Width:	93mm [3.625in]
Depth:	277mm [10.9in]

A112 DUAL TIMEBASE UNIT

Sweep Range (A and B timebases)

0.1μs/cm to 0.5s/cm in 21 calibrated ranges, switched in 1, 2, 5 sequence. The B sweep range can be extended to 1.25s/cm by use of the B FINE VELocity control, and both timebases can be extended to 20ns/cm by the X5 expansion selector.

Accuracy (A and B timebases)

±5% [0.1μs/cm to 0.2s/cm] ±10% [0.5s/cm]

Linearity (A and B timebases)

Within ±1% on all ranges

Delay Time Multiplier Accuracy

0.1% or better.

X Shift

Either end of the trace may be displayed with full expansion.

X Expansion

x5 ±2% on all ranges

External X

Bandwidth [-3dB]	d.c. coupled:	d.c. to 8MHz [up to 4cm deflection]
	a.c. coupled:	10Hz to 8MHz [up to 4cm deflection]
	Full screen deflection up to 3MHz	
Sensitivity	External:	100mV/cm [with x5 expansion] 500mV/cm [without x5 expansion]
	External ÷ 10	5V/cm

Impedance (Trig/Ext X)

1MΩ in parallel with 35pF on all ranges except TV [TV 100kΩ].

Maximum Input

400V [d.c. +a.c. peak]

Trigger Source

Internal
External [via front panel BNC type connector]
External 10 [via front panel BNC type connector]

These inputs may also be used as the X source on XY plot.

Internal Trigger Sensitivity

AC or DC selected:	2mm [d.c. to 10MHz] 5mm [at 30MHz]
TV/LF selected for use as LF filter:	2mm [20Hz to 1kHz]
TV/LF selected for frame pulse triggering:	Sync pulse height >1.5cm

External Trigger Sensitivity

100mV [d.c. to 10MHz]
250mV [at 30MHz]
500mV [at 50MHz]

Trigger Selection

Auto:	This mode presents a stable trace without use of the level control. With no signal input a continual base line is displayed.
AC or DC coupled:	The trigger operating point may be altered by use of the LEVEL control.
TV/LF coupled:	This selection may be used to provide stable triggering from the frame pulses of a television signal. It may also be used as an LF filter.

Delay Jitter

Not more than 1 part in 20,000.

Dimensions

Height:	162mm [6.375in]
Width:	93mm [3.625in]
Depth:	277mm [10.9in]

THE CX3500 PROBE

INTRODUCTION

A ten times attenuating passive probe. Suitable for use with oscilloscopes which have an input capacitance of between 15 and 30pF and bandwidths up to 150MHz.

SPECIFICATION

Attenuation: x10 ± 2%
Input Impedance: 10MΩ in shunt with 10.5pF ± 1pF
Will not alter the basic specification of the A100 oscilloscope system when used with that instrument.

Setting Up and First Time Operation

Using the probe and any necessary adaptor sockets obtain a square wave trace of approx. 1kHz. Adjust the trace height to approx. ¾ screen height and the width so that approx. 3 cycles are displayed.

Using the graticule lines as a gauge ensure that the top and bottom lines of the trace display no overshoot or droop, in which case the probe is ready for use.

If the trace is unsatisfactory, adjust the screw headed capacitor observed through the hole in the probe body to obtain the required shape.

If the available range of adjustment is insufficient to obtain a satisfactory trace, refer to the calibration instructions in the maintenance section of the technical manual for the probe.

Length

The overall length of the CX3500 is 1m. Two other probes are available in the series, namely, the CX3501 of 2m length and the CX3502 of 3m. The performance of the two probes is similar to that of the CX3500.

SECTION 7 Introduction

Introduction

Each modular unit of the A100 has a separate section of the servicing manual allocated to it.

Each section contains the following information:-

1. Circuit diagrams
2. Circuit description
3. Component location and access information
4. PCB layout diagrams
5. Calibration procedures
6. Test information
7. Parts lists

Most of the information is contained in sub-sections, each based on a particular circuit diagram. The circuit diagram throws clear to the right of the book. Each circuit diagram has a complementary left hand throw-clear on a preceding page showing an identical blue background pattern, which contains descriptive text applicable to that circuit. In certain cases, where description is unnecessary, there is no complementary throw-clear to the circuit diagram, as with attenuator and switching diagrams. The pages between the left hand and right hand throw-clears contain information on component location, access, calibration and testing, applicable to that particular circuit.

This method of layout gives all the information necessary to investigate a fault, locate the components and recalibrate after rectification, contained in a small group of pages.

Information of a general nature, not applicable to a particular circuit diagram, is given at the beginning of each section. The parts list for each unit is given at the end of each section.

Circuit Description

The overall circuit description is given in the form of a large scale block diagram, Fig. 7.1, showing an A100 main frame complete with an A101 Y-module and an A111 X-module.

Functional Blocks

The circuit diagrams are broken down into functional blocks defined by a blue background and identified by a three or four letter reference. The background shape and reference are allocated to the blocks in both the circuit diagram and the block text diagram. The reference letters also apply to the overall block diagram for the A100 system (Fig. 7.1). As this block diagram throws clear to the left, it can be read in conjunction with the circuit diagram under consideration, thus establishing the position of the circuit in the overall system.

It should be noted that a circuit diagram is not necessarily that of a complete printed circuit board (pcb). Also, a circuit diagram may include parts of more than one pcb.

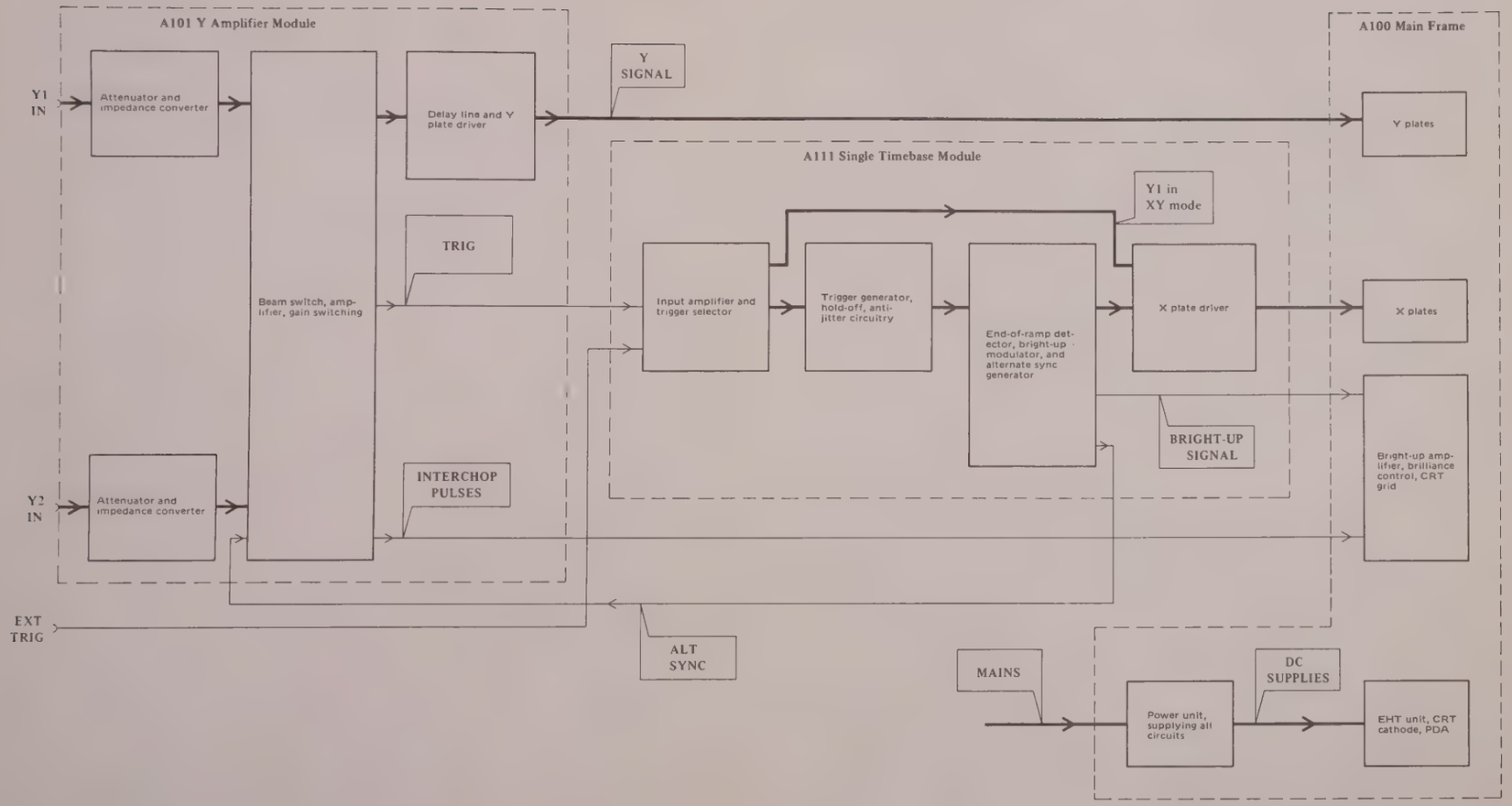


Fig. 7.1 A100 System Block Diagram

Power Rails

Inside the functional blocks the power rails are depicted as short detached bars, annotated with the nominal voltage and with a reference letter where applicable. The decoupling and voltage dropping components, and in some cases voltage regulators, are given in separate diagrams on the same or an adjacent page.

Component Numbering

Components are numbered with reference to the assembly or pcb on which they are mounted. On a circuit diagram, therefore, there may be more than one component carrying the same number. Great care must therefore be taken when locating a component by means of the pcb layout diagrams, or when identifying a component in the parts list, to ensure that the number is for that component on the correct pcb.

Test Information

Test information points are indicated on most of the circuit diagrams and are located on the appropriate pcb layout diagram. The readings that may be obtained at these points are shown on an adjacent page. It is stressed, however, that indicated readings are only obtainable on a serviceable instrument under the test conditions specified at the beginning of each section.

It should be noted that the test information is given only for assistance in fault finding and should not be interpreted as calibration measurements. Also, later modifications may alter the readings shown.

Calibration

The procedures given in this handbook assume, unless otherwise stated, that the covers have been removed and the instrument has been switched on for at least 30 minutes.

Mechanical

Removal of Modules

1. Remove the top and side covers from the instrument. Each side panel is secured by one captive screw visible through a recessed hole in the moulded end flange of the panel. Undo the screw and slide the panel to the rear. The top panel can be slid out when the side panels are removed.
2. Remove the top front bar of the main frame. This is secured by six screws - one at each end and four along the top.
3. Remove the lower front securing screw of the module. This is visible through a D-shaped hole in the bottom plate of the main frame.
4. Disconnect the appropriate CRT plate leads.
5. Disconnect the film wire connector at the rear of the module.
6. Below the film wire connector, two blue screws can be seen. Slacken these about 2 turns.
7. Lift out the module.

Replacement of Modules

This is the reverse of the removal procedure; when replacing the Y module, care must be taken not to disturb the settings of the attenuator input capacitors.

The Y plate leads are coloured pink (upper) and white (lower). The X plate leads are coloured blue (left) and violet (right) as viewed from the front of the instrument.

A100R RACK MOUNTING OSCILLOSCOPE

The A100R is a rack mounted version of the A100 oscilloscope, designed for standard 19 inch double-sided racks. The A100R, as supplied, includes a pair of runners in kit form, enabling the customer to assemble the runners to the dimensions of his rack.

The runners are assembled as shown in figs.7.3 and 7.4 and fitted to the rack by the outer set of holes. This will ensure that the runners are in the correct position to support the instrument.

When the instrument is installed in the rack, the grommets may be removed to allow connecting leads to pass from the rear of the rack to the front panel connectors.

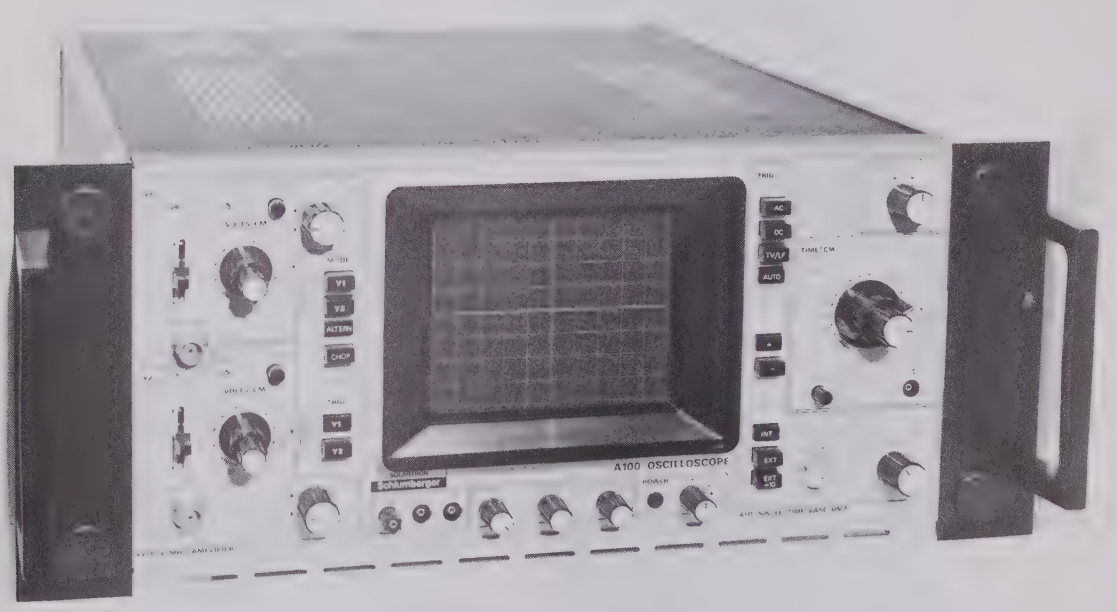


Fig.7.2 A100R - General View

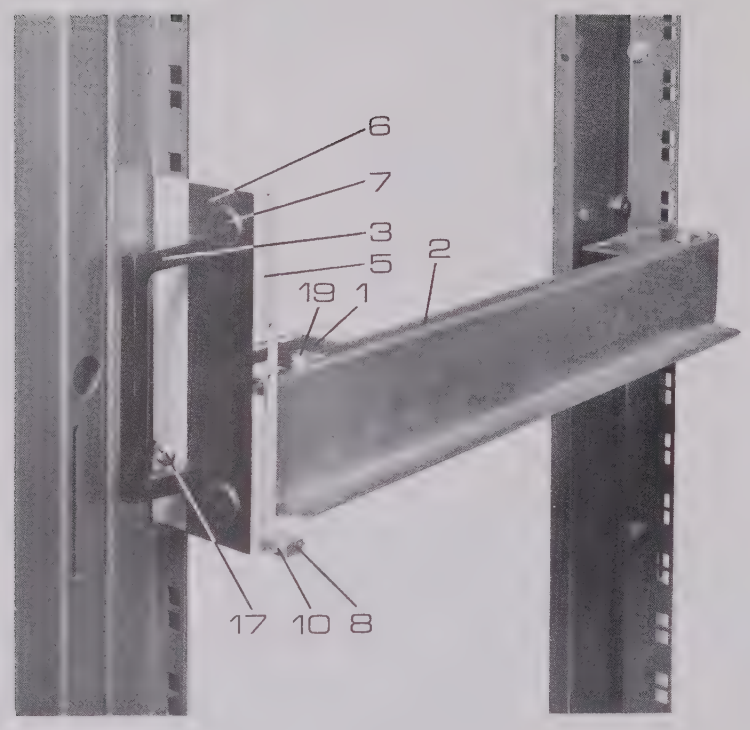


Fig.7.3 Rackmount Assembly - Front View

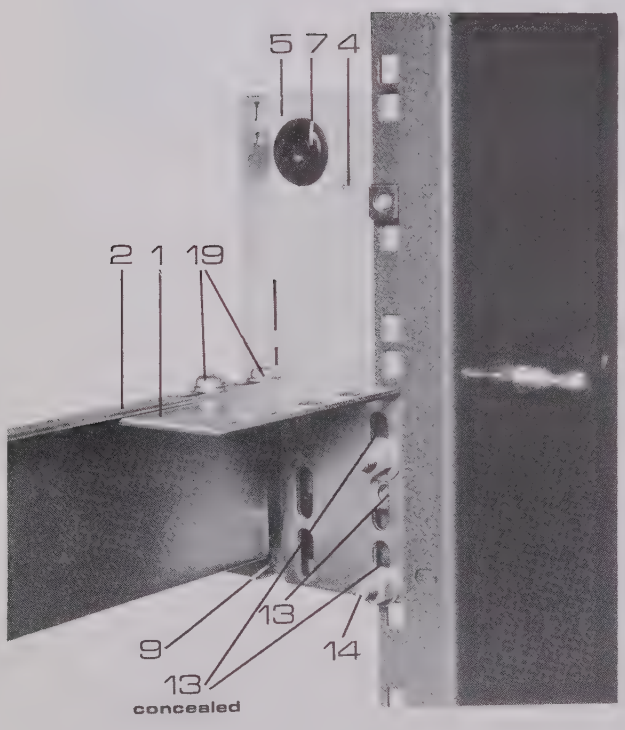


Fig.7.4 Rackmount Assembly - Detail Rear View

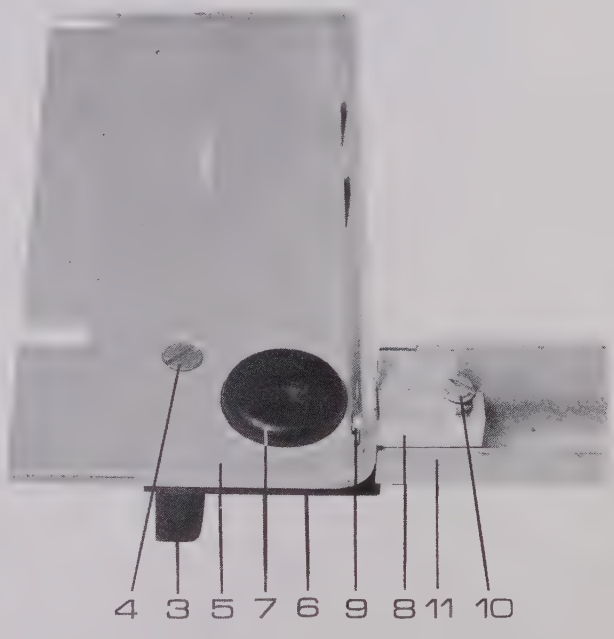


Fig.7.5 Rear View of Handle Assembly

To Install the A100R in a Rack

1. Referring to fig. 7.4, fit cage nuts (item 13) to the front of the rack at the positions indicated.

2. Fit the special small-head screws to the cage nuts indentified as "13 concealed" on fig.7.4. When screwed home, the special screw will spread the ears of the cage nut, thus securing it.

3. Fit cage nuts to the holes in the rear uprights which correspond to the holes identified in the paragraph above. Fit cage-nut screws to these.

4. Attach an angle bracket (item 1) to the front and rear, as shown in figs.7.3 and 7.4. Secure with nuts, (item 15) and washers (item 16). Before tightening, raise the bracket as far as possible.

5. Attach the runner (item 2) using OBA screws, nuts and washers, (items 19, 20 and 21). The runner may fitted either above or below the angle bracket, depending on the exact dimensions of the rack.

6. Slide in the oscilloscope on the runners. Check that the D-shaped slots in the rack ears align which the appropriate cage nuts. If not, slacken the nuts securing the brackets and adjust as necessary.

To Convert A100 to A100R

1. Remove the insert in the round escutcheon at each handle fixing point. This will expose the handle securing screws - undo the screws and remove the handle. Take out the bottom plate (see page 7.2), remove the four feet and replace the plate.

2. Assemble the rack ear components, items 3 to 10, as shown in figs. 7.5 and 7.6 Note that, although both rack ears are identical, the trim strip fixing blocks are fitted so that a left and right pair result. Note also that the trim strip grip screws are fitted with the screw head to the rear.

3. Remove the black vertical bar at each side of the instrument's front panel. Using the same screws, replace one with a rack ear assembly, with the trim strip block at the bottom.

4. Fit the trim strip, (item 11), around the trim strip block, with the slots outwards and the long flange upwards. Fit the other rack ear assembly to secure the trim strip.

WARNING - When securing the rack ear assemblies to the main frame, take care not to damage the threads in the aluminium top and bottom frame bars.

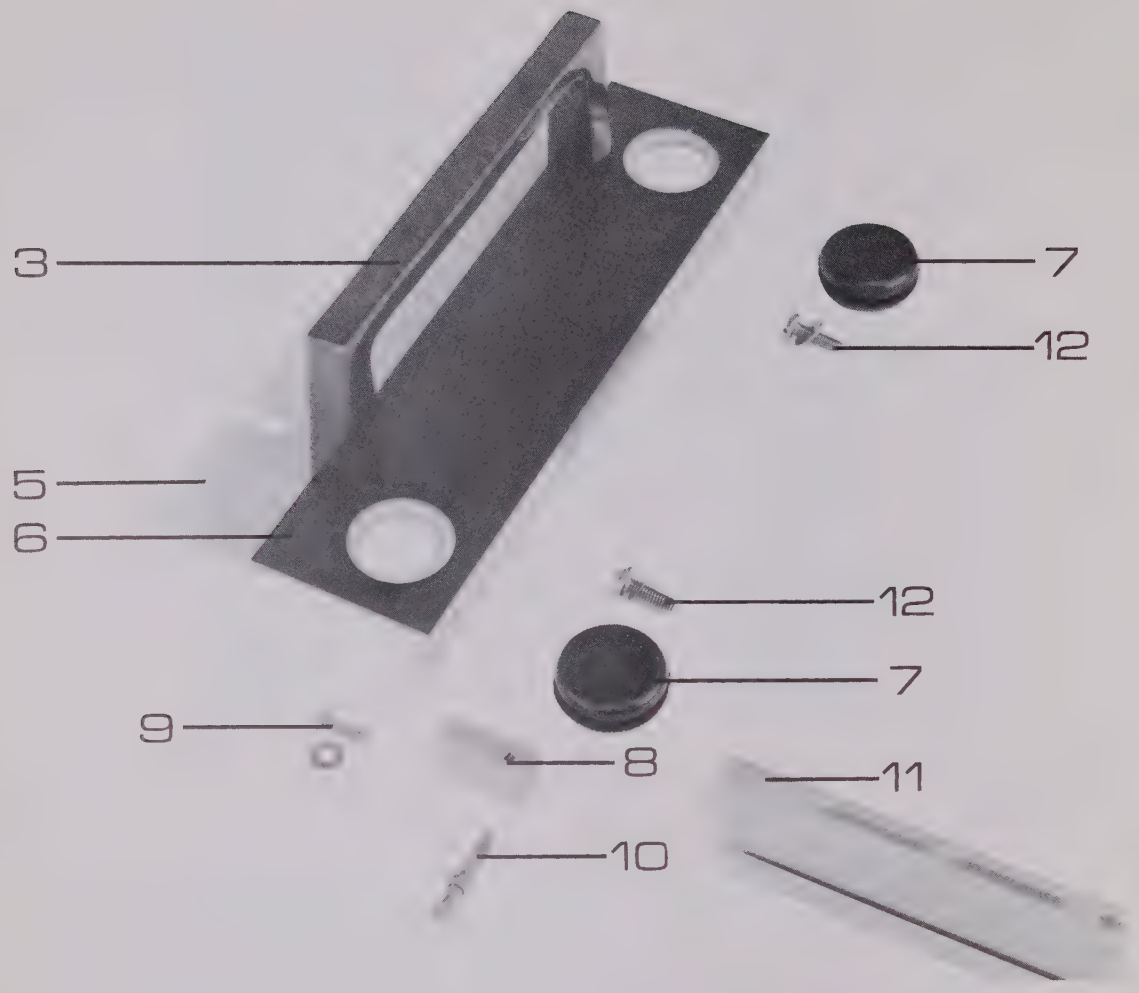


Fig.7.6 Handle and Trim Strip Components

Component Parts of Rackmount Modification Kit.

	Item	Quantity Supplied
1.	Angle bracket	4
2.	Runner	2
3.	Handle	2
4.	Handle securing screws	4
5.	Rack ear	2
6.	Trim plate	2
7.	Blind grommet	4
8.	Trim strip fixing block	2
9.	Block securing screws	2
10.	Trim strip grip screws and locknuts.	2
11.	Trim strip	1
12:	Main frame side member screws	Part of A100

If an A100R is ordered, items 3 - 12 will already be fitted

The following items of hardware are also required but not supplied.

	Item	Quantity Required
13.	Rack cage nuts	12
14.	Cage nut screws	8
15.	Full nuts, same thread as cage nut	8
16.	Washers for above	8
17.	Instrument head screws, thread as cage nuts	4
18.	Washers for above	4
19.	OBA x½inch or similar size screws	8
20.	Full nuts for above	8
21.	Washers for above	16

SECTION 8 Main Frame A100

This section contains all calibration procedures, circuit diagrams and descriptive text for the A100 main frame.

The main frame unit consists of the CRT circuitry, power supplies, bright-up amplifier and calibrator. The remainder of the oscilloscope is contained in the X and Y modules which are mounted in the main frame. A descriptive block diagram of the main frame is given in Fig. 8.4 on page 8.5.

Outline Calibration Procedures

For a full calibration, adjustments should be made in the order given in table 8.1.

Table 8.1 A100 Calibration

Procedure	Description	Test Equipment Required
100 Cal 1	Power supply voltages and ripple levels	1, 2
100 Cal 2	EHT voltages and ripple levels	1, 2, 4, 5, 6
100 Cal 3	CRT trace alignment and geometry	
100 Cal 4	Bright-up amplifier	1, 2, 5, 7
100 Cal 5	Calibrator	2, 3

Test Equipment Requirements

Item	Description	Minimum Specification	Suggested Instrument
1	Test oscilloscope	10mV/cm, 12ns risetime	Solartron A100
2	Digital voltmeter	30mV - 1600V ± 0.1%	
3	Frequency counter	1kHz	
4	Variac transformer	Mains nominal ± 10%	
5	High impedance probe	10MΩ	Solartron CX3500
6	Blocking capacitor	0.01μF 2kV	
7	Square wave generator	1MHz 1ns risetime	Tektronix 106
8	A101 Y amplifier		
9	A111 or A112 timebase		

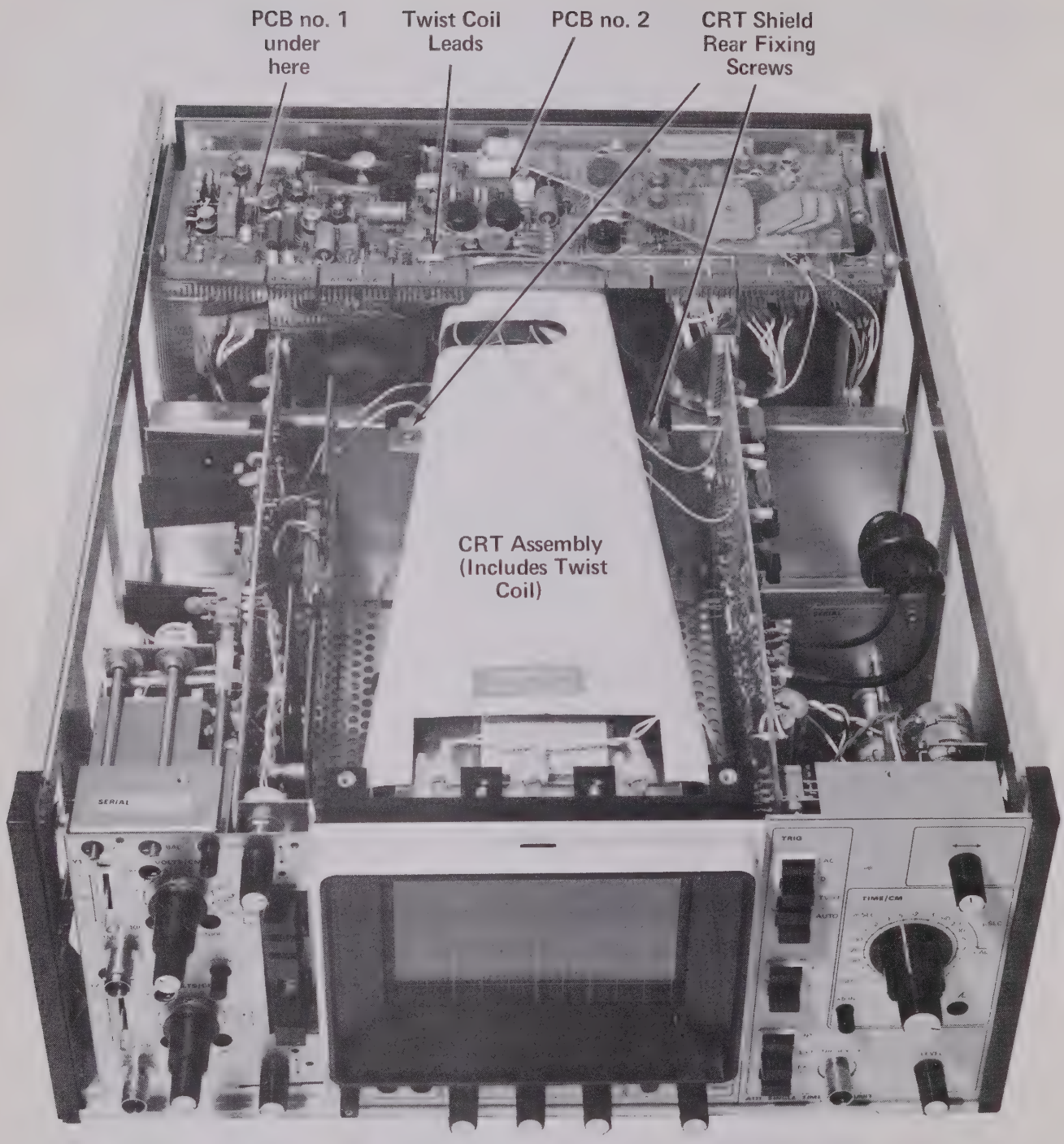


Fig. 8.1 A100 System Top View

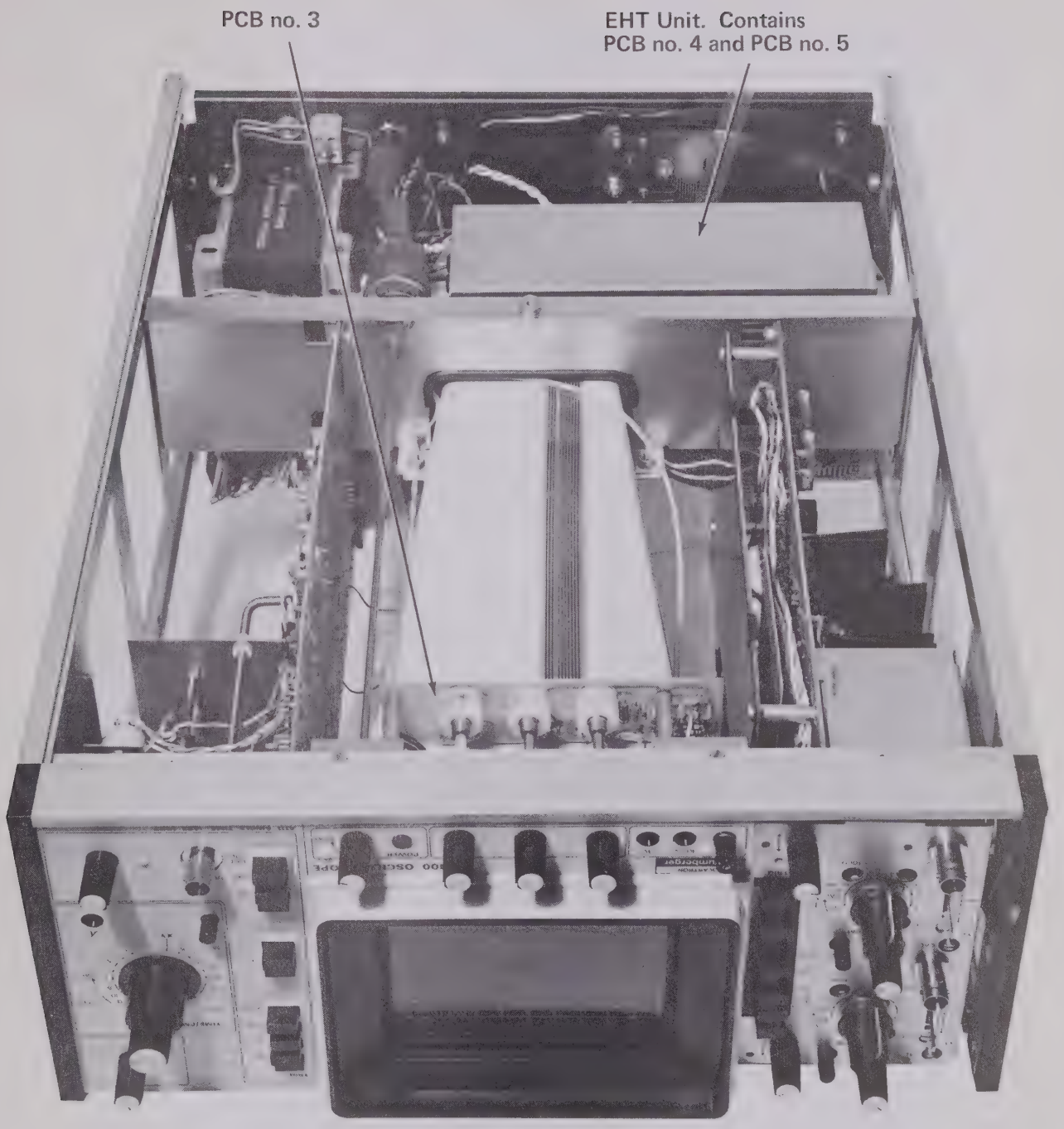


Fig. 8.2 A100 System Bottom View

Removal and Replacement of the CRT

1. Remove the top and side covers and the top front bar from the main frame. (See page 7.2 - 'Removal of modules' para. 1 and 2).

2. Referring to Fig. 8.3a, remove screws from both sides of the instrument at locations marked 'A'. Loosen those marked 'B'.

3. Remove the protective cover from pcb no. 2.

4. Remove all connections from pcb no. 2, including the two leads soldered to points near TP12.

5. Hinge back the power unit assembly as shown in Fig. 8.3a. **Caution - ensure that the film wire assemblies are not in a position where they may be damaged.**

6. Remove the CRT base from the tube.

7. Remove the black insert from the CRT bezel. This will expose four screws securing the white surround; undo these screws and remove the bezel.

8. Referring to Fig.8.3b, remove the two screws marked 'C'.

9. Remove the two CRT shield rear fixing screws (See Fig. 8.1).

10. Remove the leads from the CRT plate pins.

11. Disconnect the PDA cap and short its nipple to chassis. **(Caution - this connector carries 8.5kV).**

12. Using a clip lead, short the PDA of the CRT to chassis. If a spark results, wait for 5 minutes and repeat the operation.

13. Lift out the CRT assembly.

14. Remove the four screws marked 'D' on Fig. 8.3b and pull the graticule assembly away from the CRT face.

15. Slide the CRT out from the shield.

16. Remove the gun shield and twist coil.

17. Re-assemble in the reverse order. When re-connecting the two soldered leads to pcb no. 2, the wire coloured **violet/white/red** is connected to the forward end of C38, just behind TP12, and the wire coloured **violet** is connected to the forward end of a 560kΩ resistor (R54) to the right of TP12.

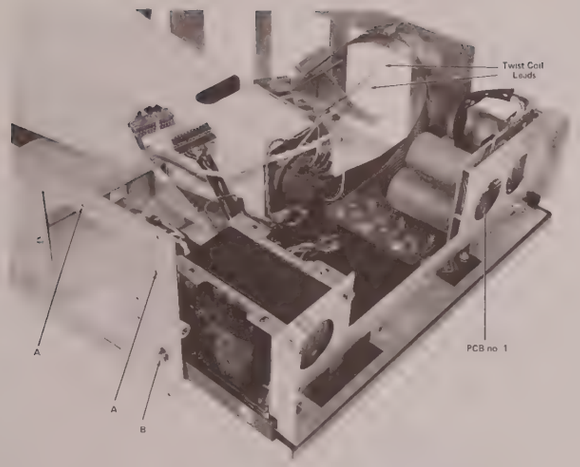


Fig. 8.3a CRT Removal

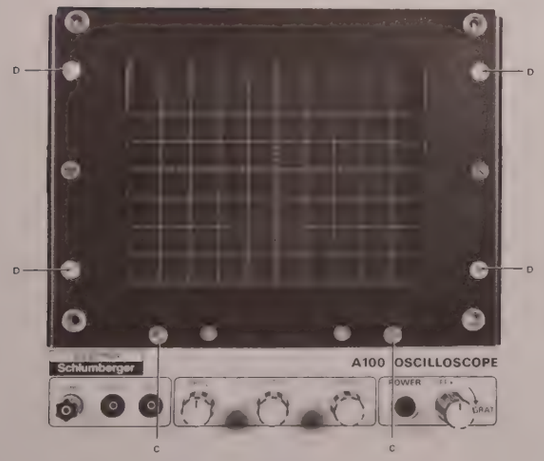


Fig. 8.3b CRT Removal

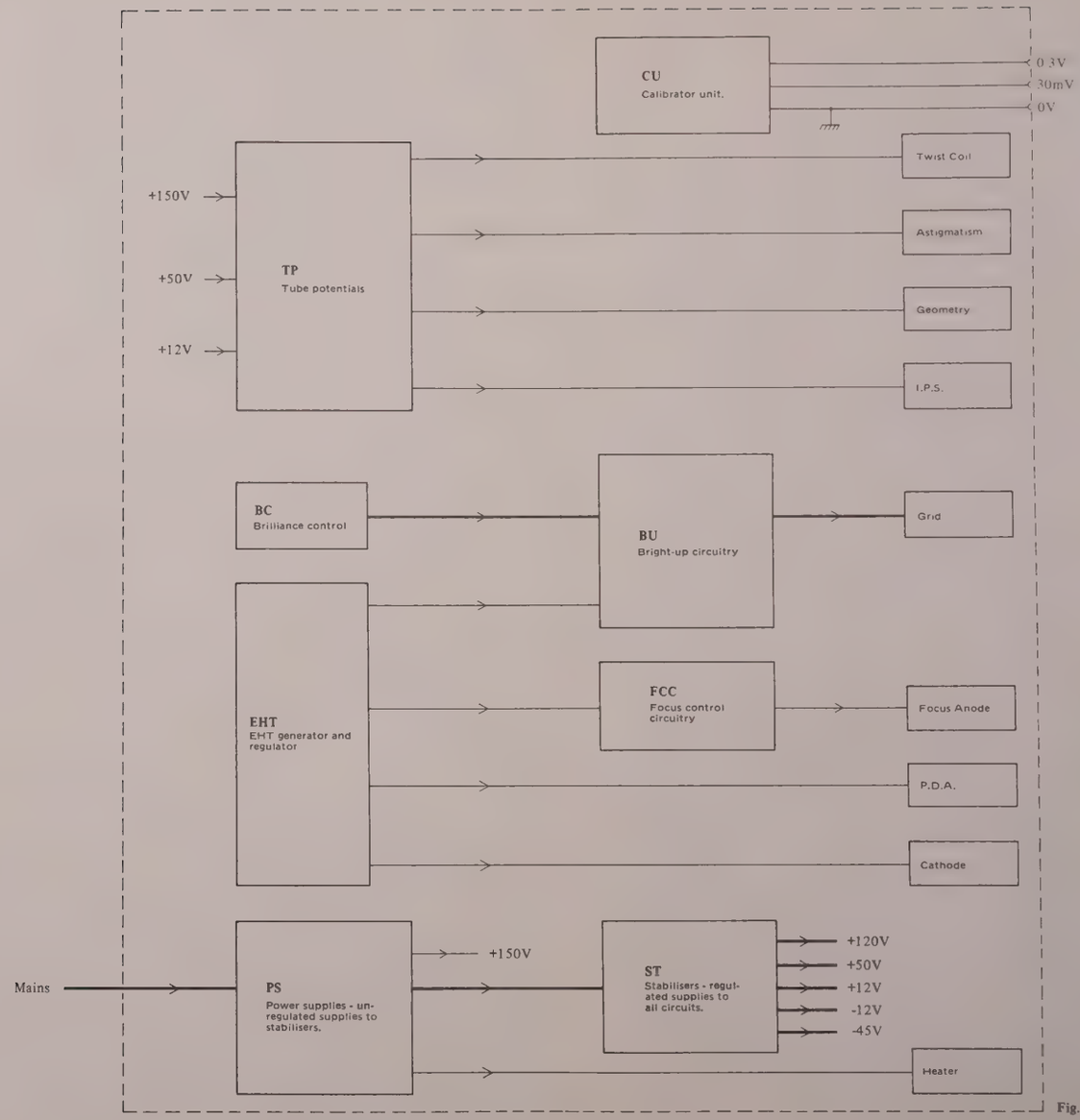


Fig. 8.4 A100 Main Frame Block Diagram

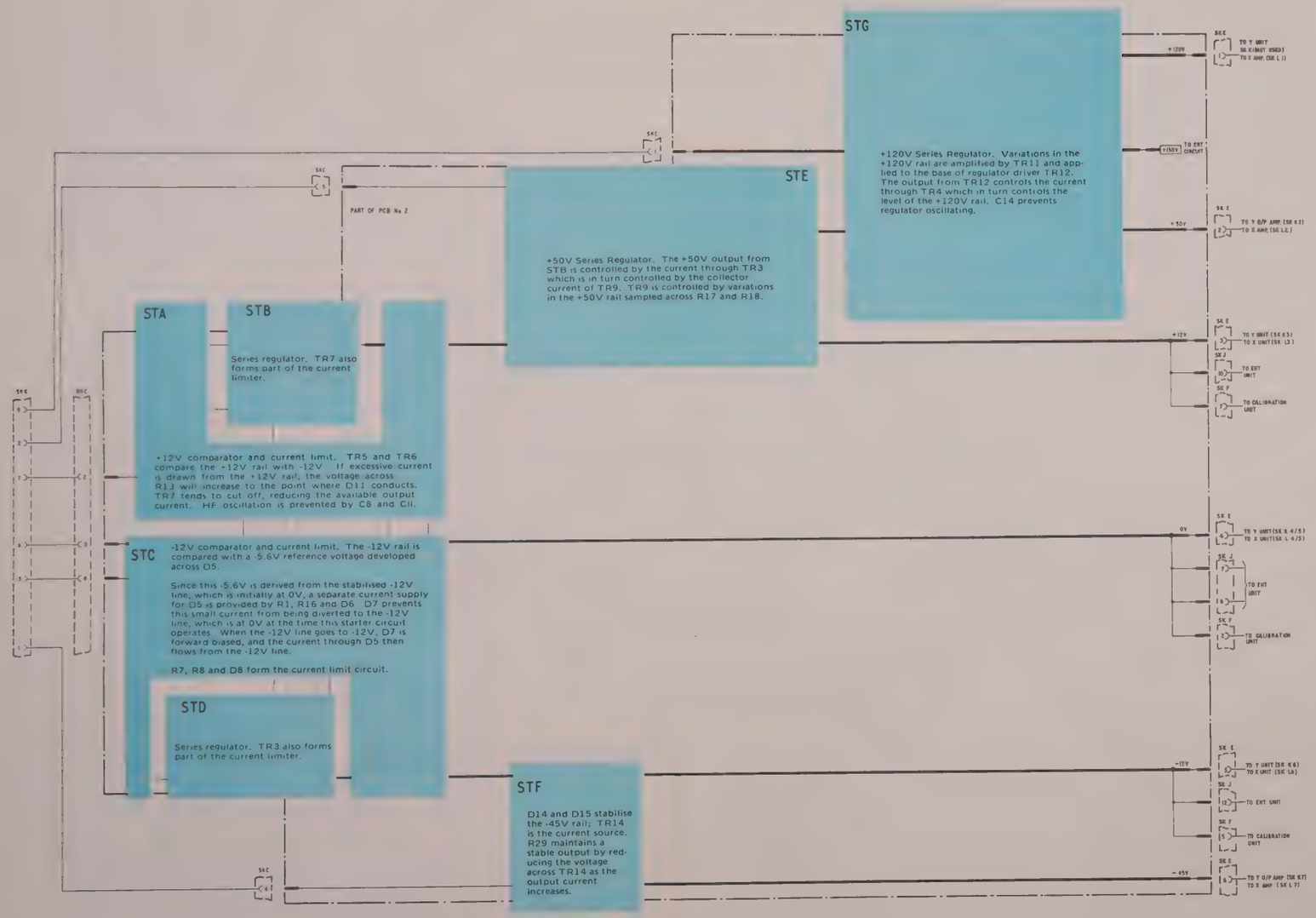

STG
+120V Series Regulator. Variations in the +120V rail are amplified by TR11 and applied to the base of regulator driver TR12. The output from TR12 controls the current through TR4 which in turn controls the level of the +120V rail. C14 prevents regulator oscillating.
STE
+50V Series Regulator. The +50V output from ST8 is controlled by the current through TR3 which is in turn controlled by the collector current of TR9. TR9 is controlled by variations in the +50V rail sampled across R17 and R18.
STA
STB
Series regulator. TR7 also forms part of the current limiter.
+12V comparator and current limit. TR5 and TR6 compare the +12V rail with -12V. If excessive current is drawn from the +12V rail, the voltage across R13 will increase to the point where D11 conducts. TR7 tends to cut off, reducing the available output current. HF oscillation is prevented by C8 and C11.
STC
-12V comparator and current limit. The -12V rail is compared with a -5.6V reference voltage developed across D5.
Since this -5.6V is derived from the stabilised -12V line, which is initially at 0V, a separate current supply for D5 is provided by R1, R16 and D6. D7 prevents this small current from being diverted to the -12V line, which is at 0V at the time this starter circuit operates. When the -12V line goes to -12V, D7 is forward biased, and the current through D5 then flows from the -12V line.
R7, R8 and D8 form the current limit circuit.
STD
Series regulator. TR3 also forms part of the current limiter.
STF
D14 and D15 stabilise the -45V rail; TR14 is the current source. R29 maintains a stable output by reducing the voltage across TR14 as the output current increases.
PART OF PCB No 2
+120V
+150V
TO EXT CIRCUIT
+50V
+12V
0V
-12V
-45V
TO EXT UNIT
TO CALIBRATION UNIT

Fig. 8.5 Power Supply Stabilisers Block Diagram

Procedure 100 Cal 1

Power supply voltages, ripple levels and regulation.

1. Ensure that X and Y modules are fitted.
2. Connect the instrument's mains lead to the output of the variac (test equipment item 4). Connect the variac to the mains and set its output to 215V or 240V, depending on the mains voltage selected in the oscilloscope. Switch on, and allow the instrument to warm up for 30 minutes.
3. Connect the DVM between earth and TP1 on pcb No. 2. Adjust RV1 to obtain a reading of -12V ± 20mV.
4. Vary the instrument's mains input voltage between the limits 200-230V or 230-250V, depending on the selected mains voltage, and ensure that the DVM reading does not vary by more than 50mV.
5. Measure the ripple level of the -12V supply with the monitor oscilloscope, and ensure that it does not exceed 10mV peak-peak.
6. Measure the voltages and ripple levels of the +12V, +50V, +120V and -45V supplies, and ensure that they are within the limits specified in table 8.2 on page 8.9.

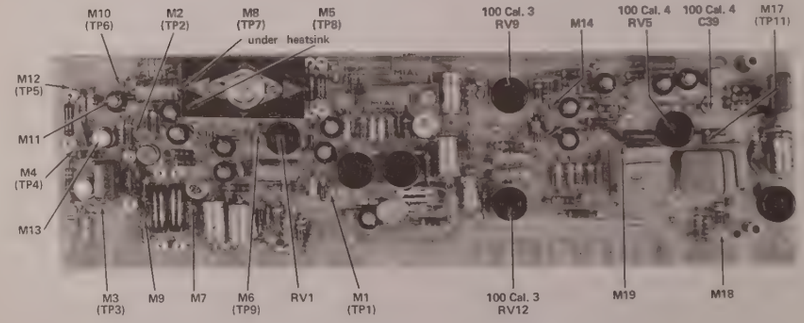


Fig. 8.6 PCB no.2

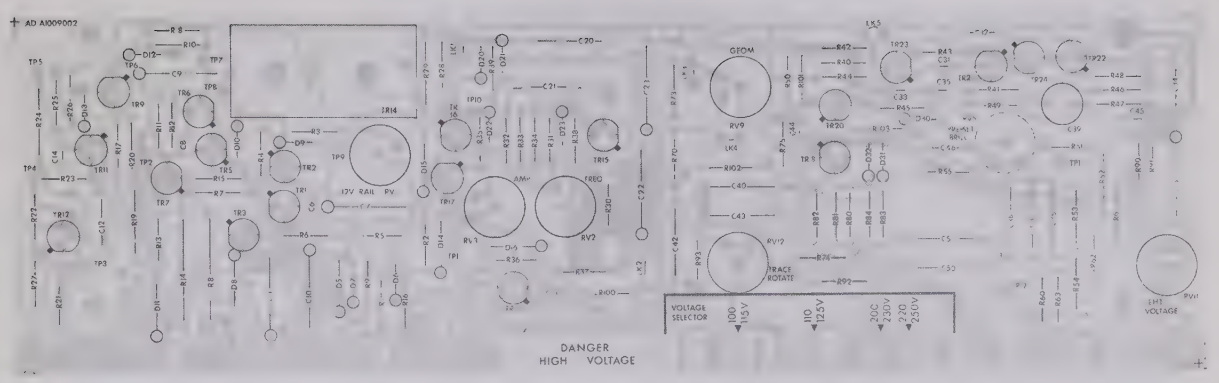


Fig. 8.7 PCB no. 2 (Component Side)

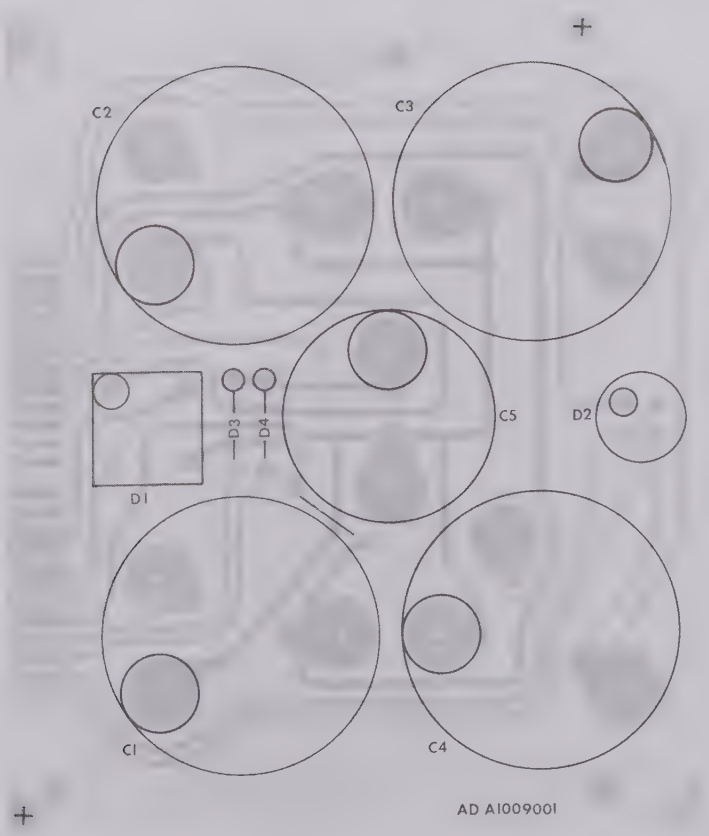


Fig. 8.8 PCB no. 1 (Component Side)

PSA
PSB
L
N
E
Mains supply selection. Operation on different mains voltages is decided by positioning the edge connector SKA at the appropriate place on pcb no.2. This block also contains the mains filter R1, R2, C1, C2, which prevent any spurious HF signals on the mains from reaching the power unit.
Rectification and smoothing. Provides the raw supplies to the stabiliser section of the power unit.
9
2
7
8
TO A1007001 SHEET 2 SKG (REGULATOR)
6
3
4
1

Fig. 8.9 Unregulated DC Supplies Block Diagram

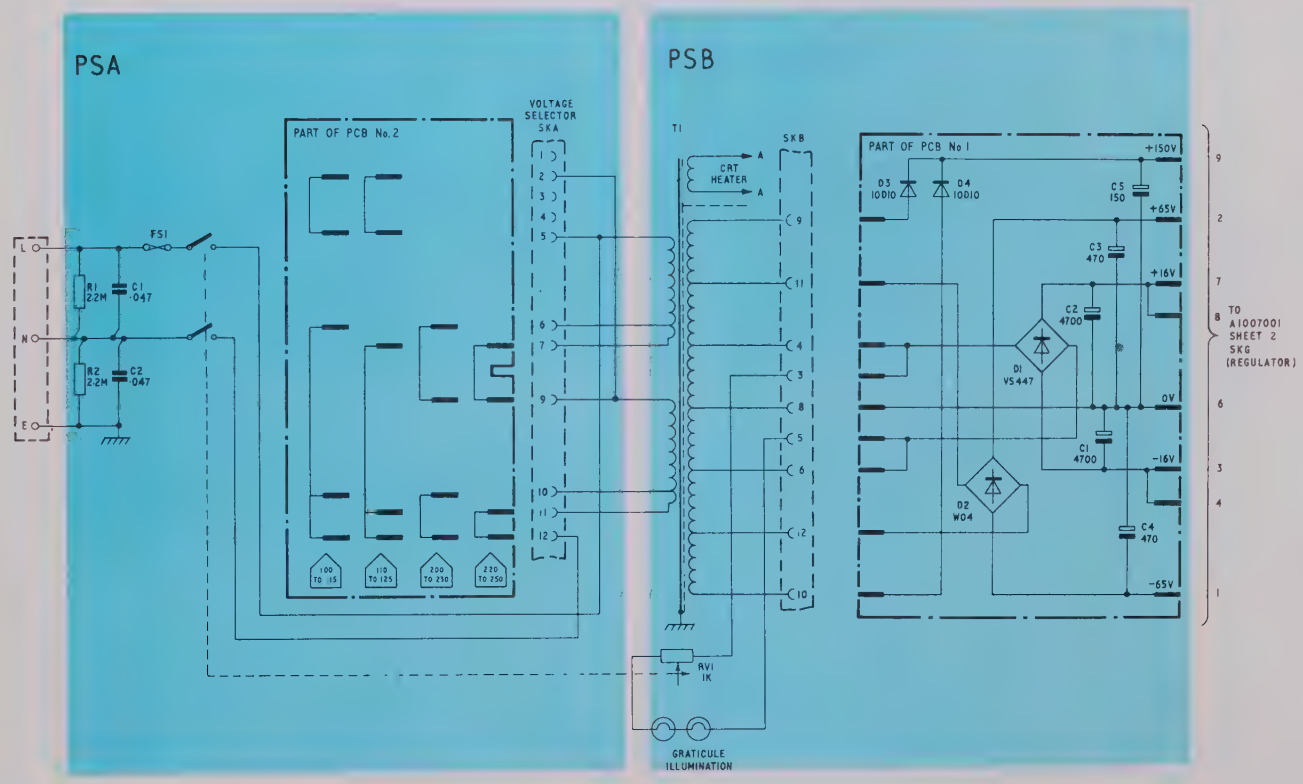
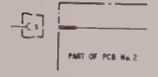


Fig. 8.10 Unregulated DC Supplies (DA1007001 Sht. 1)

Circuit Notes

Disconnect pin no. 2 of pcb no. 2



Edge connector no. 5 of pcb no. 2

Test information point

Table 8.2 Power Supplies Test Information M1 to M13

Point	Measurement wrt ⏚	Maximum Ripple p-p wrt ⏚	Remarks
M1 (TP1)	-12V ± 20mV	10mV	-12V supply
M2 (TP2)	+11.65V to +12.55V	10mV	+12V supply
M3 (TP3)	+48.5V to +55V	200mV	+50V supply
M4 (TP4)	+116V to +138V	2V	+120V supply
M5 (TP8)	-43V to -50V	100mV	-45V supply
M6 (TP9)	-5.64V		
M7	-15.7V		
M8 (TP7)	+10.4mV		
M9	+17.4V		
M10 (TP6)	+12.5V		
M11	+22.2V		
M12 (TP5)	+52.5V		
M13	+129V		

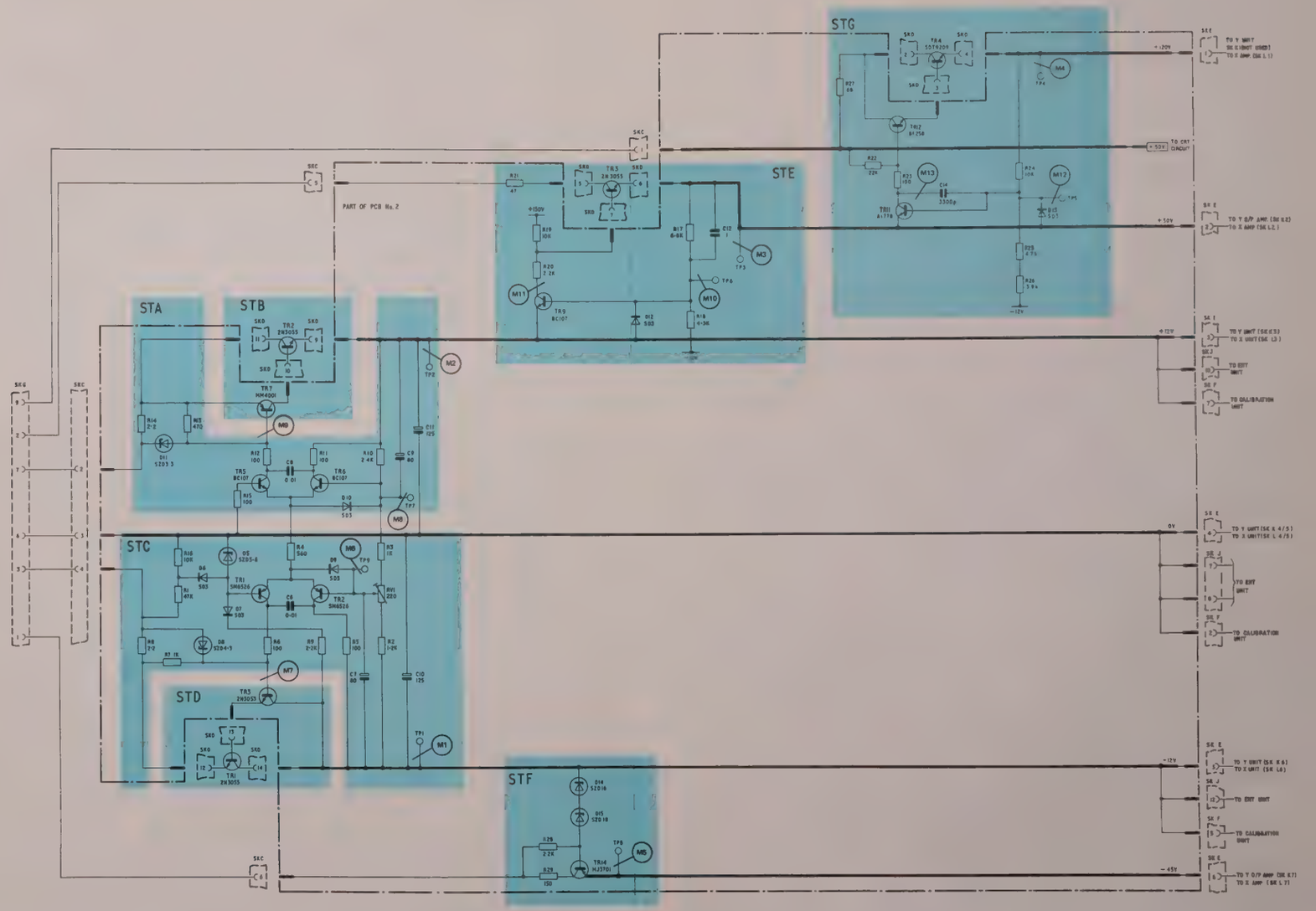


Fig. 8.11 Power Supply Stabilisers (DA1007001 Sht. 2)

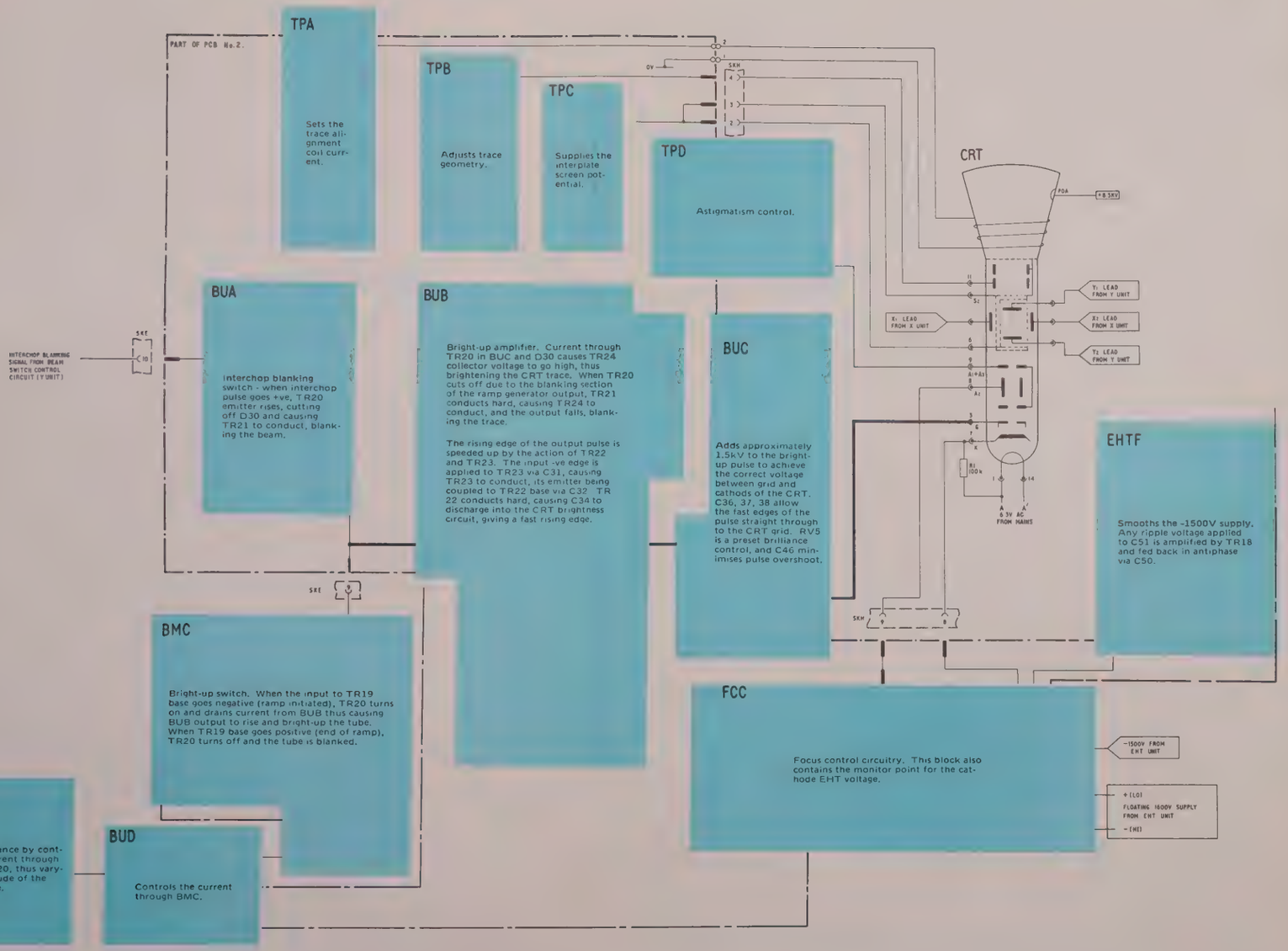

TPA
PART OF PCB No.2.
Sets the trace alignment coil current.
TPB
Adjusts trace geometry.
TPC
Supplies the interplate screen potential.
TPD
Astigmatism control.
CRT
BUA
Interchop blanking switch - when interchop pulse goes +ve, TR20 emitter rises, cutting off D30 and causing TR21 to conduct, blanking the beam.
BUB
Bright-up amplifier. Current through TR20 in BUC and D30 causes TR24 collector voltage to go high, thus brightening the CRT trace. When TR20 cuts off due to the blanking section of the ramp generator output, TR21 conducts hard, causing TR24 to conduct, and the output falls, blanking the trace.
The rising edge of the output pulse is speeded up by the action of TR22 and TR23. The input -ve edge is applied to TR23 via C31, causing TR23 to conduct, its emitter being coupled to TR22 base via C32. TR22 conducts hard, causing C34 to discharge into the CRT brightness circuit, giving a fast rising edge.
BUC
Adds approximately 1.5kV to the bright-up pulse to achieve the correct voltage between grid and cathods of the CRT. C36, 37, 38 allow the fast edges of the pulse straight through to the CRT grid. RV5 is a preset brilliance control, and C46 minimises pulse overshoot.
EHTF
Smooths the -1500V supply. Any ripple voltage applied to C51 is amplified by TR18 and fed back in antiphase via C50.
BMC
Bright-up switch. When the input to TR19 base goes negative (ramp initiated), TR20 turns on and drains current from BUB thus causing BUB output to rise and bright-up the tube. When TR19 base goes positive (end of ramp), TR20 turns off and the tube is blanked.
FCC
Focus control circuitry. This block also contains the monitor point for the cathode EHT voltage.
BCA
Controls brilliance by controlling the current through TR19 and TR20, thus varying the amplitude of the bright-up pulse.
BUD
Controls the current through BMC.
INTERCHOP BLANKING SIGNAL FROM BEAM SWITCH CONTROL CIRCUIT (Y UNIT)
SKE
SKH
0V
+8.5KV
Y1 LEAD FROM Y UNIT
X2 LEAD FROM X UNIT
Y2 LEAD FROM Y UNIT
X1 LEAD FROM X UNIT
6.3V AC FROM MAINS
-1500V FROM EHT UNIT
+ (LO)
FLOATING 1600V SUPPLY FROM EHT UNIT
- (HI)

Fig. 8.12 CRT and Bright-up Circuits Block Diagram

Procedure 100 Cal 3

CRT trace alignment and geometry.

1. Obtain a single line trace. Adjust RV12 on pcb No. 2 to set the trace parallel to a horizontal graticule line.

2. Obtain a raster display. Adjust RV9 (GEOM) on pcb No. 2 to eliminate any pincushion or barrel distortion.

Procedure 100 Cal 4

Bright-up amplifier.

1. Obtain a single line trace. Select XY on the timebase switch; a single bright spot should now be displayed.

2. Set BRILL control approximately 90 degrees clockwise.

3. Adjust RV5 on pcb No. 2 for normal display brilliance.

4. Turn BRILL control slowly anticlockwise and check that the spot extinguishes before minimum control setting is reached. If not, readjust RV5.

5. Set TIME/CM to XY. Connect the DVM to TP11 on pcb No. 2. Turn FOCUS control fully anticlockwise to avoid damaging the CRT phosphor. Adjust BRILL control for a reading of 30V on the DVM with respect to chassis. Remove the DVM.

6. Set TIME/CM to 0.5μs/cm. Connect the Tektronix 106 fast-rise output to Y1 input via 50Ω in-line termination. Adjust generator amplitude for about 6cm picture.

7. Connect the monitor oscilloscope to TP11 via a 10MΩ probe. Adjust C39 on pcb No.2 for optimum square-wave with a risetime of not greater than 55ns.

Fig. 8.13 PCB no. 2 (Component Side)

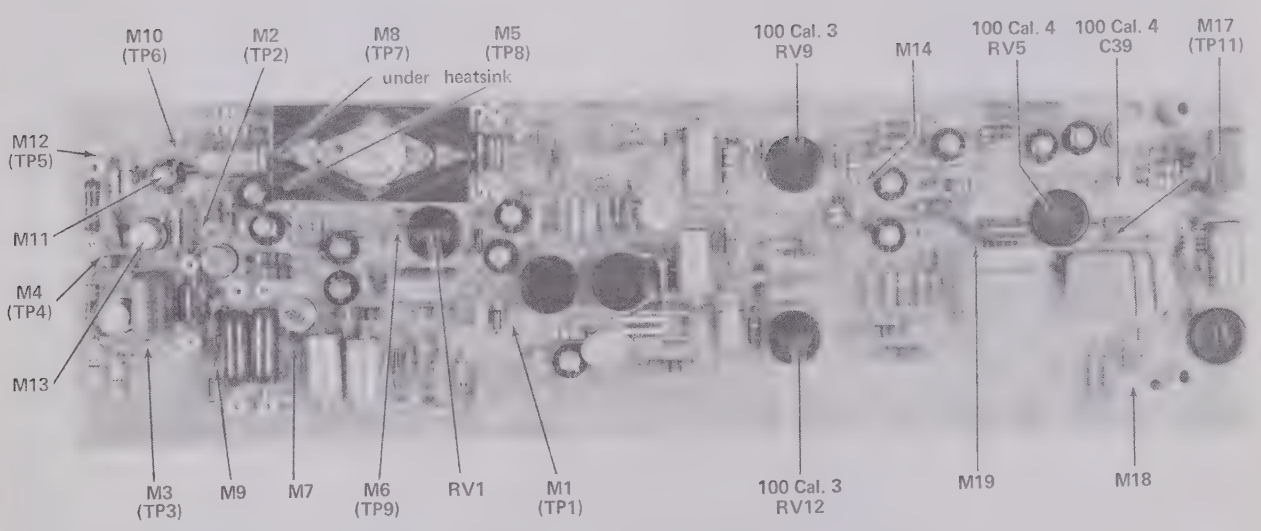
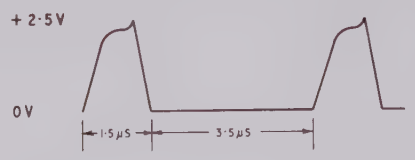
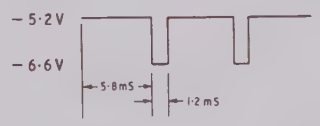
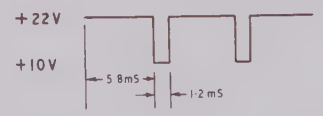
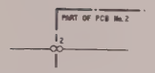


Fig. 8.14 PCB no. 2

Table 8.3 Test Information Points M14 to M20 - CRT and Bright-Up

Point	Measurement at Standard Settings	Remarks
M14		
M15		Observed at X unit. See A111 ramp generator or A112 'B' ramp generator circuits.
M16		
M17 (TP11)		This is the final bright-up signal before 1620 volts is added.
M18 (hi) to M19 (lo)	1620V ± 5V Ripple 1V p-p max.	Measure ripple between M18 and chassis with oscilloscope connected via a .01μF 2kV capacitor.
M20	-1500V ± 2V Ripple 200mV p-p max.	Measure ripple with oscilloscope connected via a .01μF 2kV capacitor.

Circuit Notes



Disconnect pin no. 2 of pcb no. 2

Edge connector no. 5 of pcb no. 2

Test information point

On some models, R61 and R62 are 2.7MΩ, R63 is 3.3MΩ, and R60 is 1.8MΩ.

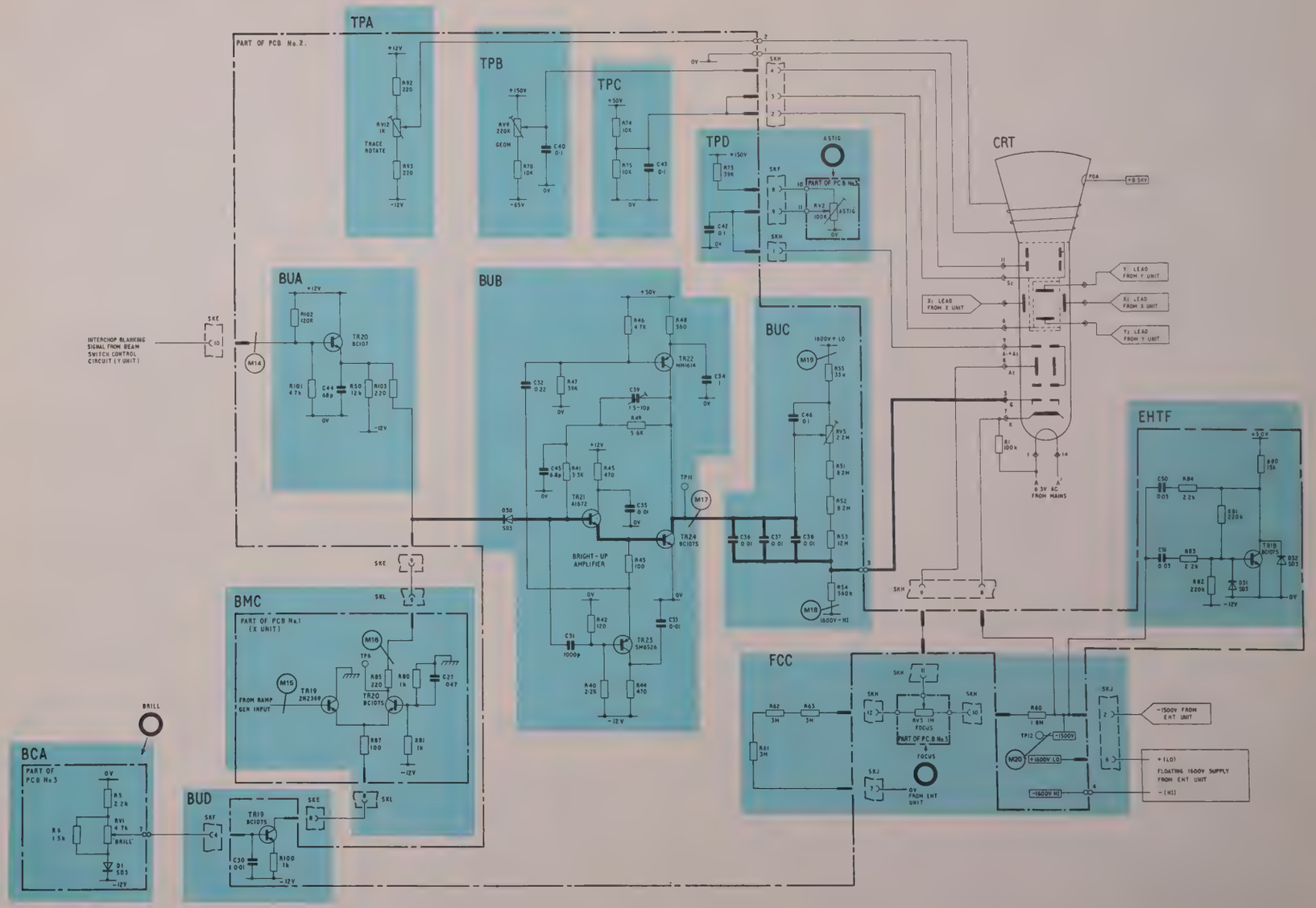


Fig. 8.15 CRT and Bright-up Circuits (DA1007002)

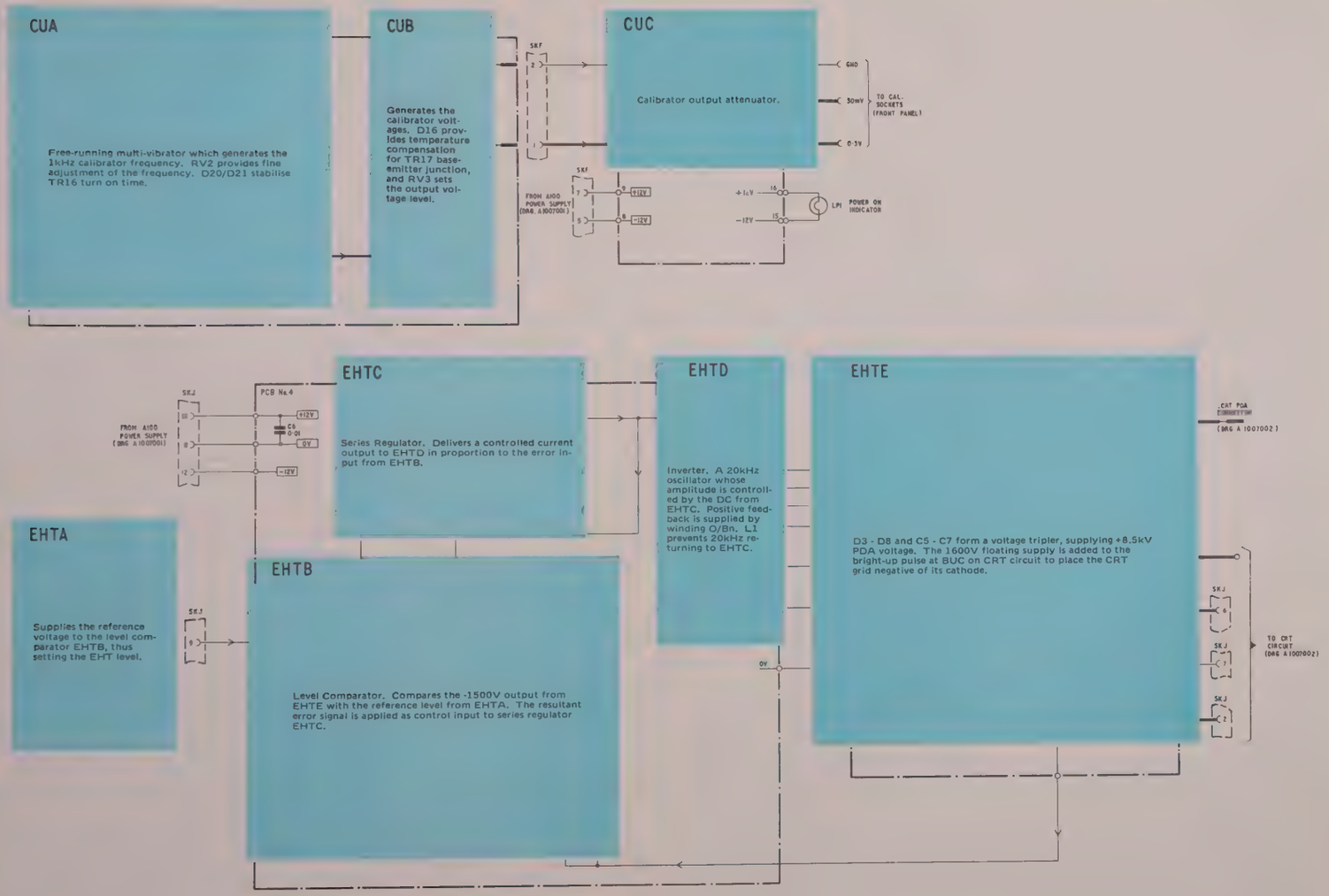

CUA
Free-running multi-vibrator which generates the 1kHz calibrator frequency. RV2 provides fine adjustment of the frequency. D20/D21 stabilise TR16 turn on time.
CUB
Generates the calibrator voltages. D16 provides temperature compensation for TR17 base-emitter junction, and RV3 sets the output voltage level.
CUC
Calibrator output attenuator.
GND
30mV
0·3V
TO CAL. SOCKETS (FRONT PANEL)
SKF
FROM A100 POWER SUPPLY (DWG. A100700)
+12V
-12V
+1·4V
-12V
LPI
POWER ON INDICATOR
EHTA
Supplies the reference voltage to the level comparator EHTB, thus setting the EHT level.
EHTB
Level Comparator. Compares the -1500V output from EHTE with the reference level from EHTA. The resultant error signal is applied as control input to series regulator EHTC.
EHTC
Series Regulator. Delivers a controlled current output to EHTD in proportion to the error input from EHTB.
PCB No.4
C6 0·01
0V
EHTD
Inverter. A 20kHz oscillator whose amplitude is controlled by the DC from EHTC. Positive feedback is supplied by winding O/Bn. L1 prevents 20kHz returning to EHTC.
EHTE
D3 - D8 and C5 - C7 form a voltage tripler, supplying +8.5kV PDA voltage. The 1600V floating supply is added to the bright-up pulse at BUC on CRT circuit to place the CRT grid negative of its cathode.
CRT PDA CONNECTION (DWG A 1007002)
SKJ
TO CRT CIRCUIT (DWG A 1007002)
0V

Fig. 8.16 EHT Generator and Calibrator Block Diagram

Procedure 100 Cal 2

EHT voltages and ripple levels.

1. Connect the DVM between chassis and TP12 on pcb No. 2. (TP12 is on Fig. 8.15 in block FCC). Adjust RV11 on pcb No. 2 for -1500V ± 2V. Disconnect the DVM.
2. Connect a 0.01μF, 2kV capacitor to TP12, and connect the monitor oscilloscope to the other leg of the capacitor. Measure the ripple; this should not exceed 200mV p-p.
3. Check the 1620V floating supply between points M18 (HI) and M19 (LO) as shown in table 8.3. on page 8-12.

Procedure 100 Cal 5

Calibrator

1. Connect the frequency counter to the calibrator 0.3V output. Adjust RV2 on pcb No. 2 for a reading of 1kHz ± 2Hz.
2. Remove TR15 (this is a plug-in transistor on pcb No. 2). Connect the DVM to the 0.3V output, and adjust RV3 on pcb No. 2 to obtain a reading of 300mV ± 1mV.
3. Transfer the DVM to the 30mV output. Check that the output is 30mV ± 0.6mV. If not, readjust RV3 to bring both outputs within specification.
4. Replace TR15.

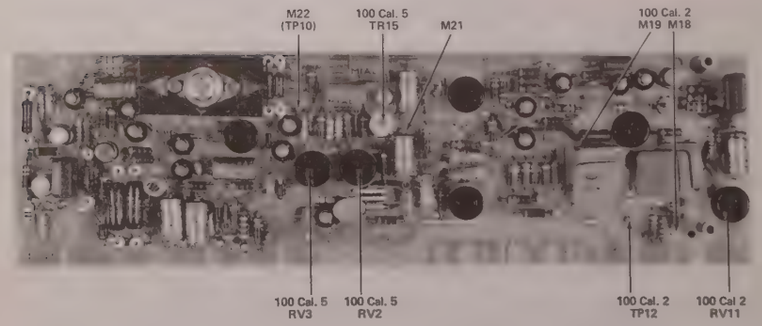


Fig. 8.17 PCB no. 2

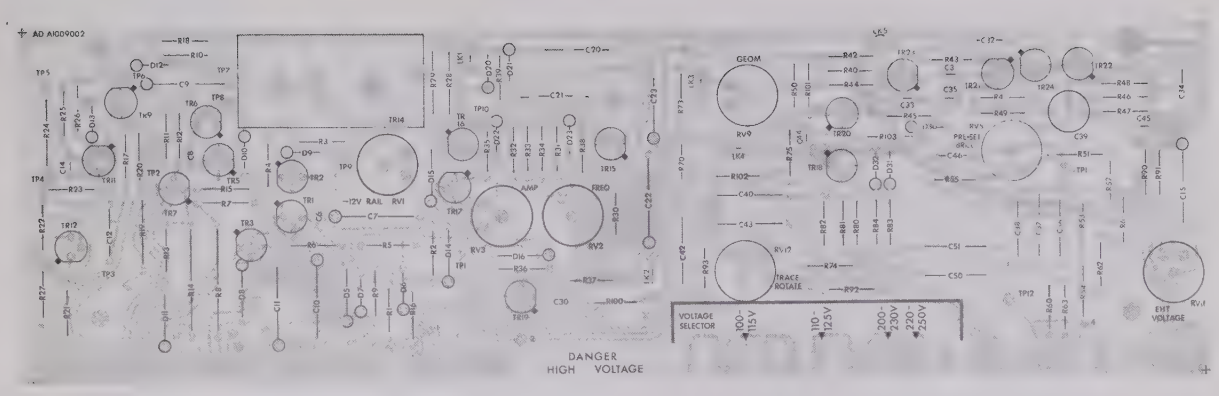


Fig. 8.18 PCB no. 2 (Component Side)

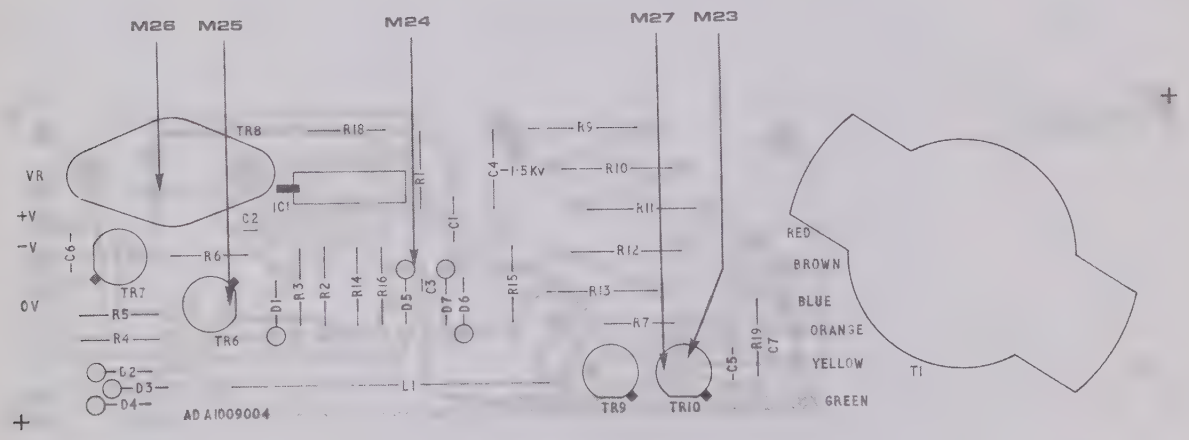


Fig. 8.19 PCB no. 4 (Copper Side)

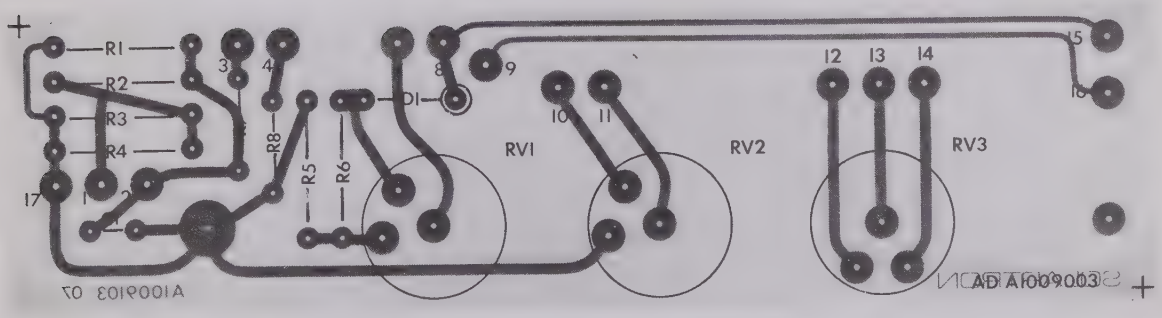
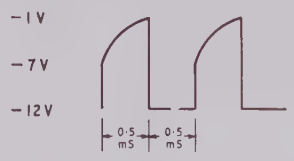
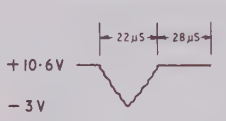


Fig. 8.20 PCB no. 5 (Component Side)

Table 8.4 Test Information M5 to M11 - Calibrator and EHT

Point	Measurement at Standard Settings	Remarks
M21	-5.57V	
M22		
M23		Points M23 to M27 are contained in the EHT unit.
M24	-5.6V	
M25	-0.6V	
M26	+8.5V	
M27		

Circuit Notes

Disconnect pin no. 2 of pcb no. 2

Edge connector no. 5 of pcb no. 2

Test information point

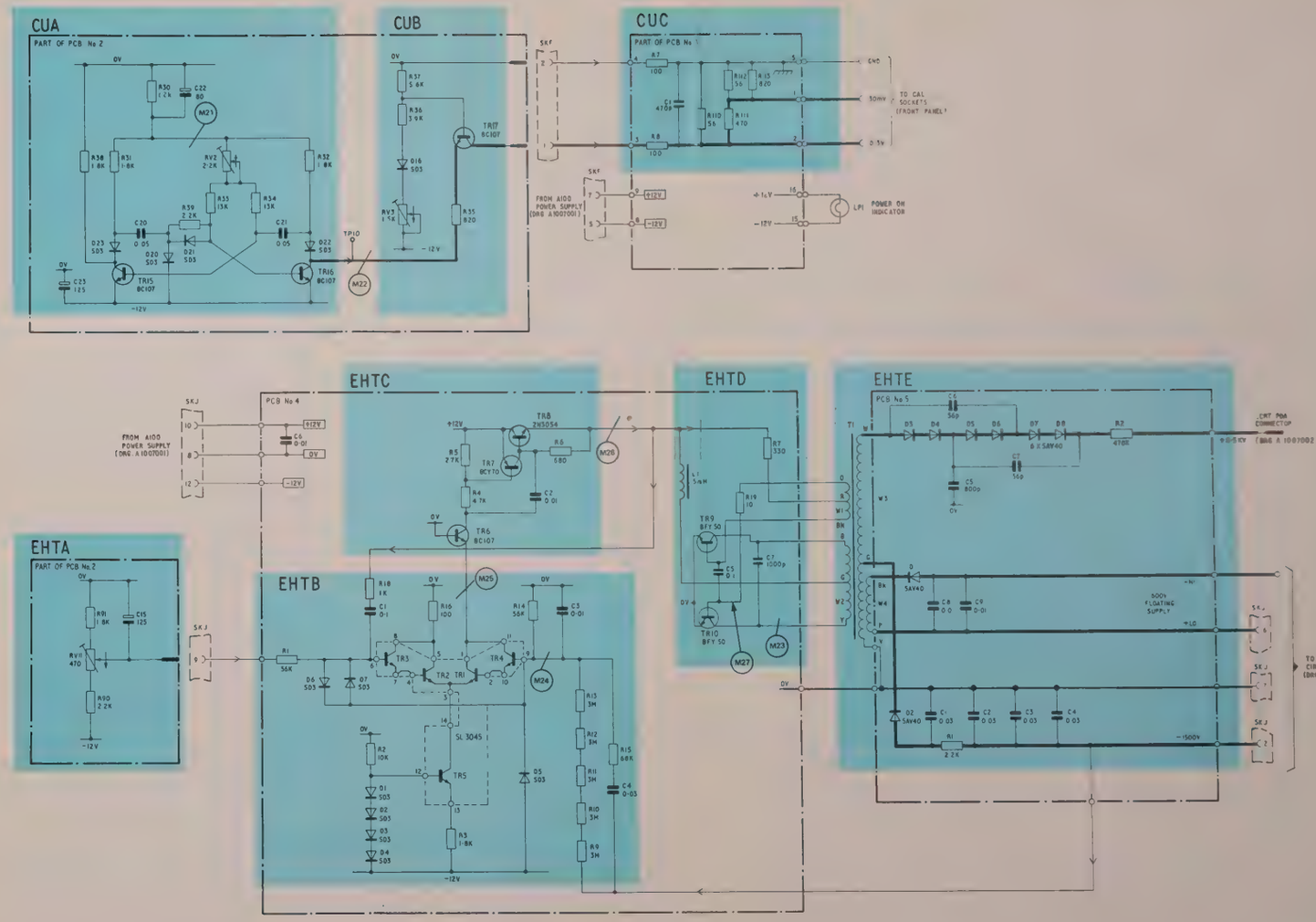


Fig. 8.21 EHT Generator and Calibrator (DA1007003)

COMPONENT PARTS LIST

ABBREVIATIONS

Circuit References

B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

Component Composition

FIXED RESISTORS

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Component Composition (Cont'd)

VARIABLE RESISTORS

Wirewound Preset Single Turn	WWPS
Wirewound Preset Multiturn	WWPM
Wirewound Front Panel Single Turn	WWFS
Wirewound Front Panel Multiturn	WWFM
Carbon Preset Single Turn	CAPS
Carbon Preset Multiturn	CAPM
Carbon Front Panel Single Turn	CAFS
Carbon Front Panel Multiturn	CAFM
Cermet Preset Single Turn	CMPS
Cermet Preset Multiturn	CMPM
Cermet Front Panel Single Turn	CMFS
Cermet Front Panel Multiturn	CMFM

CAPACITORS

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Column 4 indicates rating (Watts or Volts)
Column 5 indicates tolerance (%)

Component Parts List for General Assembly

Cct. Ref.	General Description				Solartron Part No.
R1	CACP	100k	.25	10	172351000
RV10	CAFS	1k	1	20	119600101
LP1	Pilot Lamp Assy.				300710700
LP2	Lamp Filament L.E.S. 12V				300710370
LP3	Lamp Filament L.E.S. 12V				300710370
SKS	Socket 2mm Black				352501590
SKT	Socket 2mm Black				352501590
SKU	Terminal 2mm Black				355001270
V1	Cathode Ray Tube with SKT				300100202

Component Parts List for Power Supply Assembly

Cct. Ref.	General Description				Solartron Part No.
R1	CACP	2.2M	.25w	10	172362200
R2	CACP	2.2M	.25w	10	172362200
C1	PAPM	.047	630v	20	208300050
C2	PAPM	.047	630v	20	208300050
TR1	2N3055				300552340
TR2	2N3055				300552340
TR3	2N3055				300552340
TR4	SDT9209				300554020
T1	Transformer Mains				309600904

Component Parts List for EHT Generator

Cct. Ref.	General Description	Solartron Part No.
T1	EHT Transformer Bobbin	309600705
T1	Ferrite Core	309010290

See also pcb no.4 and pcb no.5.

Component Parts List for PCB No.1 (A1009001)

Cct. Ref.	General Description	Solartron Part No.
C1	ALME 5000	208600210
C2	ALME 5000	208600210
C3	ALME 500	208600200
C4	ALME 500	208600200
C5	ALME 100	208600069
D1	Rectifier Bridge Waycom VS447	300524940
D2	Rectifier Bridge	300524700
D3	Diode	300523610
D4	Diode	300523610

Component Parts List for PCB No.2 (A1009002)

Cct. Ref.	General Description				Solartron Part No.
R1	CACP	47k	.25	10	172344700
R2	MEOX	1.2k	.5	1	195431200
R3	MEOX	1k	.5	1	195431000
R4	CACP	560	.25	10	172325600
R5	CACP	100	.25	10	172321000
R6	CACP	100	.25	10	172321000
R7	CACP	1k	.25	10	172331000
R8	POWW	2.2	3	5	173702200
R9	CACP	2.2k	.25	10	172332200
R10	MEOX	2.4k	.5	1	195432400
R11	CACP	100	.25	10	172321000
R12	CACP	100	.25	10	172321000
R13	CACP	470	.25	10	172324700
R14	POWW	2.2	3	5	173702200
R15	CACP	100	.25	10	172321000
R16	CACP	10k	.25	10	172341000
R17	MEOX	6.8k	.5	1	195436800
R18	MEOX	4.3k	.5	1	195434300
R19	POWW	10k	1.5	5	173441000
R20	CACP	2.2k	.25	10	172332200
R21	MEOX	47	.5	5	193514700
R22	CACP	22k	.25	10	172342200
R23	CACP	100	.25	10	172321000
R24	MEOX	10k	1	1	197541000
R25	MEOX	4.7k	.5	1	195434700
R26	MEOX	3.9k	.5	1	195433900
R27	MEOX	100	.5	5	193521000
R28	POWW	2.2k	1.5	5	173432200
R29	POWW	150	1.5	5	173421500
R30	CACP	1.2k	.25	10	172331200
R31	CACP	1.8k	.25	10	172331800
R32	CACP	1.8k	.25	10	172331800
R33	MEOX	13k	.5	1	195441300
R34	MEOX	13k	.5	1	195441300
R35	MEOX	820	.5	1	195428200
R36	MEOX	3.9k	.5	1	195433900
R37	MEOX	5.6k	.5	1	195435600
R38	CACP	1.8k	.25	10	182331800
R39	CACP	2.2k	.25	10	172332200
R40	CACP	2.2k	.25	10	172332200
R41	MEOX	3.3k	.5	1	195433300
R42	CACP	120	.25	10	172321200
R43	CACP	100	.25	10	172321000
R44	CACP	470	.25	10	172324700
R45	CACP	470	.25	10	172324700
R46	CACP	4.7k	.25	10	172334700
R47	CACP	39k	.25	10	172343900
R48	CACP	560	.25	10	172325600
R49	MEOX	5.6k	.5	1	195435600
R50	CACP	12k	.25	10	172341200
R51	CACP	8.2M	.25	10	172368200
R52	CACP	8.2M	.25	10	172368200
R53	CACP	12M	.25	10	172371200
R54	CACP	560k	.25	10	172355600
R55	CACP	33k	.25	10	172343300
R60	CACP	2.2M	.25	10	172362200
R61	MEFM	3M	.25	1	198363000
R62	MEFM	3M	.25	1	198363000
R63	MEFM	3M	.25	1	198363000
R70	CACP	10k	.25	10	172341000
R73	CACP	39k	.25	10	172343900
R74	CACP	10k	.25	10	172341000
R75	CACP	10k	.25	10	172341000
R80	CACP	15k	.25	10	172341500
R81	CACP	220k	.25	10	172352200
R82	CACP	220k	.25	10	172352200
R83	CACP	2.2k	.25	10	172332200
R84	CACP	2.2k	.25	10	172332200
R90	MEOX	2.2k	.5	1	195432200
R91	MEOX	1.8k	.5	1	195431800
R92	CACP	220	.25	10	172322200
R93	CACP	220	.25	10	172322200
R100	CACP	1k	.25	10	172331000
R101	CACP	4.7k	.25	10	172334700
R102	CACP	120k	.25	10	172351200
R103	CACP	220	.25	10	172322200
RV1	WWPS	220	1	10	110037230
RV2	CAPS	2.2k	.25	10	136632200
RV3	CAPS	1k	.25	20	136631000
RV5	CAPS	2.2M	.25	20	136662200
RV9	CAPS	220k	.25	20	136652200
RV11	CAPS	470	.25	20	136624700
RV12	WWPS	1k	1	20	110027220
C6	CERM	.01	25	-20 +80	241941000
C7	ALME	80	25	-10 +50	208600230
C8	CERM	.01	25	-20 +80	241941000
C9	ALME	80	25	-10 +50	208600230
C10	ALME	125	16	-10 +50	208600220
C11	ALME	125	16	-10 +50	208600220
C12	ESTM	1	100	10	225461000
C14	CERM	3300p	500	20	241333300
C15	ALME	125	16	-10 +50	208600220
C20	STYR	.05	63	2.5	208100160
C22	ALME	80	25	-10 +50	208600230
C23	ALME	125	16	-10 +50	208600220
C30	CERM	0.1	30	-25 +50	242051000
C31	CERM	1000p	500V	20	241331000
C32	ESTM	.22	100V	10%	225452200
C33	CERM	.01	25V	-25 +50	241949000
C34	ESTM	1	100V	10	225461000

Cct. Ref.	General Description				Solartron Part No.
C35	CERM	.01	25V	-25 +50	241941000
C36	CERM	.01	2kV	-20 +80	208450005
C37	CERM	.01	2kV	-20 +80	208450005
C38	CERM	.01	2kV	-20 +80	208450005
C39	CERM	1.5/5p	50V		290030220
C40	ESTM	.1	160V	10	220351000
C42	ESTM	.1	160V	10	220351000
C43	ESTM	.1	160V	10	220351000
C44	CERM	68p	500V	20	241316800
C45	CERM	6.8p	500V	20	241306800
C46	ESTM	0.1	100V	10	225451000
C50	CERM	.03	1.5kV	-20 +80	208450003
C51	CERM	.03	1.5kV	-20 +80	208450003
D5	Diode Zener 5.6V				300521450
D6	Diode SD3				300522160
D7	Diode SD3				300522160
D8	Diode Zener 4.3V				300523900
D9	Diode SD3				300522160
D10	Diode SD3				300522160
D11	Diode Zener 3.3V				300521860
D12	Diode SD3				300522160
D13	Diode SD3				300522160
D14	Diode Zener 16V				300521320
D15	Diode Zener 18V				300521300
D16	Diode SD3				300522160
D20	Diode SD3				300522160
D21	Diode SD3				300522160
D22	Diode SD3				300522160
D23	Diode SD3				300522160
D30	Diode SD3				300522160
D31	Diode SD3				300522160
D32	Diode SD3				300522160
TR1	Transistor SM6526				300552990
TR2	Transistor SM6526				300552990
TR3	Transistor 2N3053				300551800
TR5	Transistor BC107S				300553320
TR6	Transistor BC107S				300553320
TR7	Transistor MM4001				300554050
TR9	Transistor BC107S				300553320
TR11	Transistor A1778				300551430
TR12	Transistor BF258				300554120
TR14	Transistor MJ3701				300554380
TR15 to TR20	Transistor BC107S				300553320
TR21	Transistor A1672				300551910
TR22	Transistor MM1614				300551670
TR23	Transistor SM6526				300552990
TR24	Transistor BC107S				300553320

Component Parts List

for

PCB No.3 (A1009003)

Cct Ref	General Description				Solartron Part No.
R1	MEOX	56	.5	1	195415600
R2	MEOX	470	.5	1	195424700
R3	MEOX	56	.5	1	195415600
R4	CACP	820	.25	10	172328200
R5	CACP	2.2k	.25	10	172332200
R6	CACP	1.5k	.25	10	172331500
R7	CACP	100	.125	10	172021000
R8	CACP	100	.125	10	172021000
RV1	CAFS	4.7k	.25	20	110010095
RV2	CAFS	100k	.25	20	110010174
RV3	CAFS	1M	.25	20	110010208
C1	CERM	470p	500V	20	241324700
D1	Diode SD3				300522160

Component Parts List

for

PCB No.4 (A1009004)

Cct. Ref.	General Description				Solartron Part No.
R1	CACP	56k	.25	10	172345600
R2	CACP	10k	.25	10	172341000
R3	CACP	1.8k	.25	10	172331800
R4	CACP	4.7k	.25	10	172334700
R5	CACP	2.7k	.25	10	172332700
R6	CACP	680	.25	10	172326800
R7	CACP	330	.25	10	172323300
R9	MEFM	3M	.25	1	198363003
R10	MEFM	3M	.25	1	198363003
R11	MEFM	3M	.25	1	198363003
R12	MEFM	3M	.25	1	198363003
R13	MEFM	3M	.25	1	198363003
R14	MEOX	56k	.5	1	195445600
R15	CACP	68k	.25	10	172346800
R16	CACP	100	.25	10	172321000
R18	CACP	1k	.25	10	172331000
R19	CACP	10	.25	10	172311000
C1	ESTM	.1	100	10	225451000
C2	CERM	.01	25	-25 +50	241941000
C3	CERM	.01	25	-25 +50	241941000
C4	CERM	.03	1500	-20 +80	208450003
C5	CERM	.1	30	-20 +80	242051000
C6	CERM	.01	25	-25 +50	241941000
C7	CERM	1000p	500V	20	241331000
D1 to D7	Diode SD3				300522160
TR1	5 transistor D.I.L. Package				300554090
TR2	5 transistor D.I.L. Package				300554090
TR3	5 transistor D.I.L. Package				300554090
TR4	5 transistor D.I.L. Package				300554090
TR5	5 transistor D.I.L. Package				300554090
TR6	Transistor Silicon NPN BC107S				300553320
TR7	Transistor Silicon PNP BCY70				300553590
TR8	Transistor Silicon NPN 2N3054				300552060
TR9	Transistor Silicon NPN BFY50				300553610
TR10	Transistor Silicon NPN BFY50				300553610
L1	Inductor				309500301

Component Parts List

for

PCB No.5 (A1009005)

Cct. Ref.	General Description				Solartron Part No.
R1	CACP	2.2k	.25W	1	172332200
R2	CACP	470k	.25W	1	172354700
C1	CERM	.03	1500	-20 +80	208450003
C2	CERM	.03	1500	-20 +80	208450003
C3	CERM	.03	1500	-20 +80	208450003
C4	CERM	.03	1500	-20 +80	208450003
C5	CERM	1800p	4000	-20 +80	208450014
C6	CERM	56p	8000	-20 +80	208450118
C7	CERM	56p	8000	-20 +80	208450118
C8	CERM	.01	2000	-20 +80	208450005
C9	CERM	.01	2000	-20 +80	208450005
D1	Diode Silicon EHT				300524930
D2	Diode Silicon EHT				300524930
D3	Diode Silicon EHT				300524930
D4	Diode Silicon EHT				300524930
D5	Diode Silicon EHT				300524930
D6	Diode Silicon EHT				300524930
D7	Diode Silicon EHT				300524930
D8	Diode Silicon EHT				300524930

SECTION 9 Dual Trace Y Amplifier A101

Outline Description (refer to block diagram, Fig. 9.1)

The A101 is a dual-trace Y amplifier of 30MHz bandwidth at 5mV/cm sensitivity per channel. It employs beam switching techniques to achieve the dual-trace facility; this allows conversion of the unit to a differential mode amplifier by simple switching.

Most of the signal amplification is performed by three special integrated circuits. The first-stage integrated circuit in each channel also performs the beam-switching, gain switching, shift and DC balance functions. The trigger signal is taken from another output on the first-stage integrated circuit.

The second stage integrated circuit, which is identical to the other two, provides a current output to feed a common-base amplifier which drives the CRT Y plates. This stage also provides HF compensation to achieve the amplifier's 30MHz bandwidth.

The sensitivity selector gives the standard 1,2,5 sequence of sensitivities from 5mV/cm to 20V/cm. The attenuator proper operates in decade steps, the intermediate sensitivities being achieved by altering the gain of the first signal amplifier stage.

The basic sensitivity of the Y1 amplifier can be multiplied by 10, giving an overall sensitivity of 0.5mV/cm at 2.5MHz bandwidth. This is achieved by amplifying the input signal by a factor of 9 and applying it in antiphase to the inverting (or 'signal low') input, giving an overall amplification of 10.

Outline Calibration Procedures (see page 7.2)

For a full calibration, adjustments should be made in the order given in table 9.1 below. The procedure requires a calibrated timebase unit, A111 or A112. If a complete oscilloscope is to be calibrated, the X sensitivity must first be adjusted before procedure 101 Cal 4 is performed.

Table 9.1 A101 Calibration

Procedure	Description	Test Equipment Required*
101 Cal 1	Step attenuator and variable gain balancing.	
101 Cal 2	Output amplifier centering	
101 Cal 3	Gain ratio adjustment	1
101 Cal 4	Y amplifier gain	1
101 Cal 5	X10 amplifier gain	1
101 Cal 6	Step attenuator adjustments	2, 4
101 Cal 7	HF pulse response	3, 4

* See page 9.2

Test Equipment Requirements

Item	Description	Minimum Specification	Suggested Instrument
1	Oscilloscope calibrator		Bradley 192 or 156
2	Capacitance meter	25-30pF	Tektronix 130
3	Constant amplitude signal generator	50kHz - 40MHz	Tektronix 191
4	Pulse generator	120V at 10kHz known leading edge	Tektronix 106

Servicing Information

Waveforms monitored at test information points Y1 to Y7 are all square waves: the information given consists of the mean DC level as measured on a digital voltmeter and the peak-to-peak AC voltage as measured on an oscilloscope.

The beam switch waveforms (Y8 to Y11) are not all square waves, and representative traces have been given.

Standard Settings

The waveforms and voltages at the measuring points in this instrument were taken from a serviceable instrument with the controls set as follows:

Sensitivity Y1 and Y2	50mV/cm
Variable gain	CAL
Input coupling	AC
Mode	Y1
Trigger	Y1
Y1 Shift	Centralised trace
X10	OUT
-Y2	OUT
Input signal	0.3V from calibrator

Mechanical

Removal of Melamine Front Panel

This is necessary for adjustments to the attenuator compensation capacitors. Proceed as follows:-

1. Remove module. (see page 7.2)
2. Remove knobs on attenuators, variable gain controls, Y-shift controls and input coupling lever switch.
3. Carefully lever off melamine panel. It is secured by four press-fit nylon studs, which will come away with the panel.

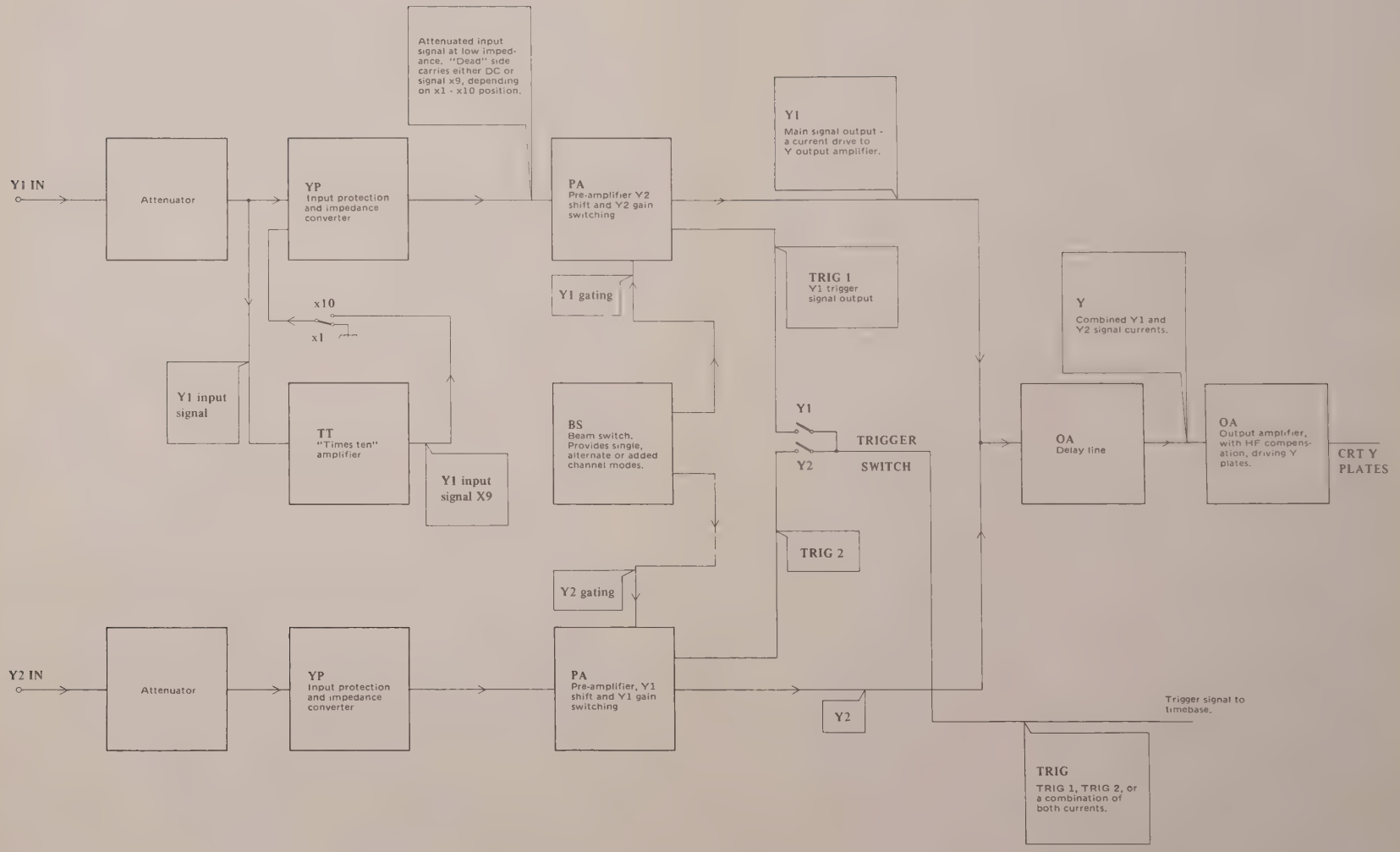


Fig. 9.1 A101 Block Diagram

Procedure 101 Cal 6

Step attenuator adjustments.

Both attenuators are identical; only Y1 will be described. Before starting adjustments, the melamine front panel must be removed (see page 9.2). Also remove the plastic main frame section covering Y1 C6 and Y2 C9 (see Fig. 9.2).

1. Set TIME/CM on timebase to 50μs, set Y1 sensitivity to 100mV/cm. Apply 10kHz square wave from Tektronix 106 to Y1 input. Set amplitude for a 6cm picture approximately.

2. Adjust ÷ 10 trimmer (C11) for optimum square wave.

3. Set Y1 sensitivity to 1V/cm, readjust generator for a 6cm picture, and adjust ÷ 100 trimmer (C8) for optimum square wave.

4. Repeat for 10V/cm, adjust ÷ 1000 trimmer (C5).

5. Apply capacitance meter to Y1 input. Refer to Fig. 9.2 for input capacitor locations.

6. Set sensitivity to 5mV/cm and adjust C2 for 28pF reading.

7. Set sensitivity to 50mV/cm and adjust C9 for 28pF reading.

8. Set sensitivity to 500mV/cm and adjust C6 for 28pF reading.

9. Set sensitivity to 5V/cm and adjust C3 for 28pF reading.

10. Repeat paras. 1-4; if any readjustment is needed, repeat paras. 5-9.

11. Repeat paras. 1-10 for Y2.

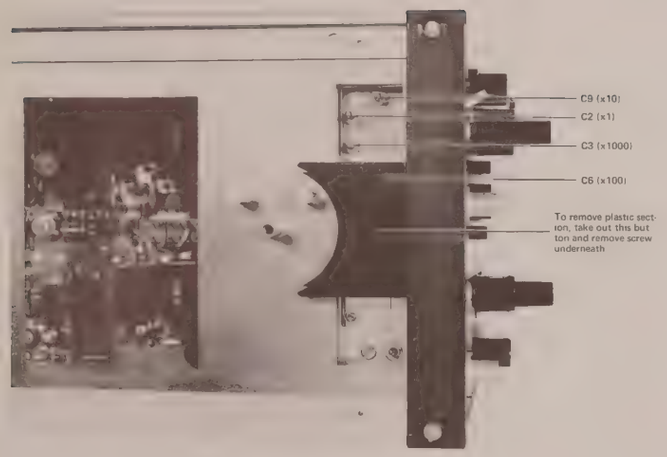


Fig. 9.2 Main Frame Left Hand Side

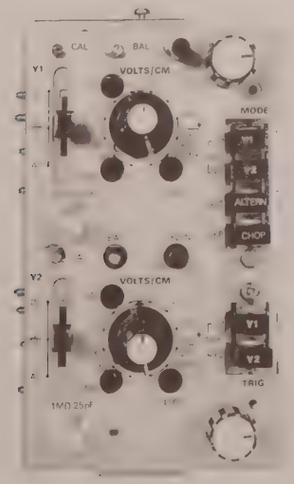


Fig. 9.3 Front Panel with Melamine Cover Removed

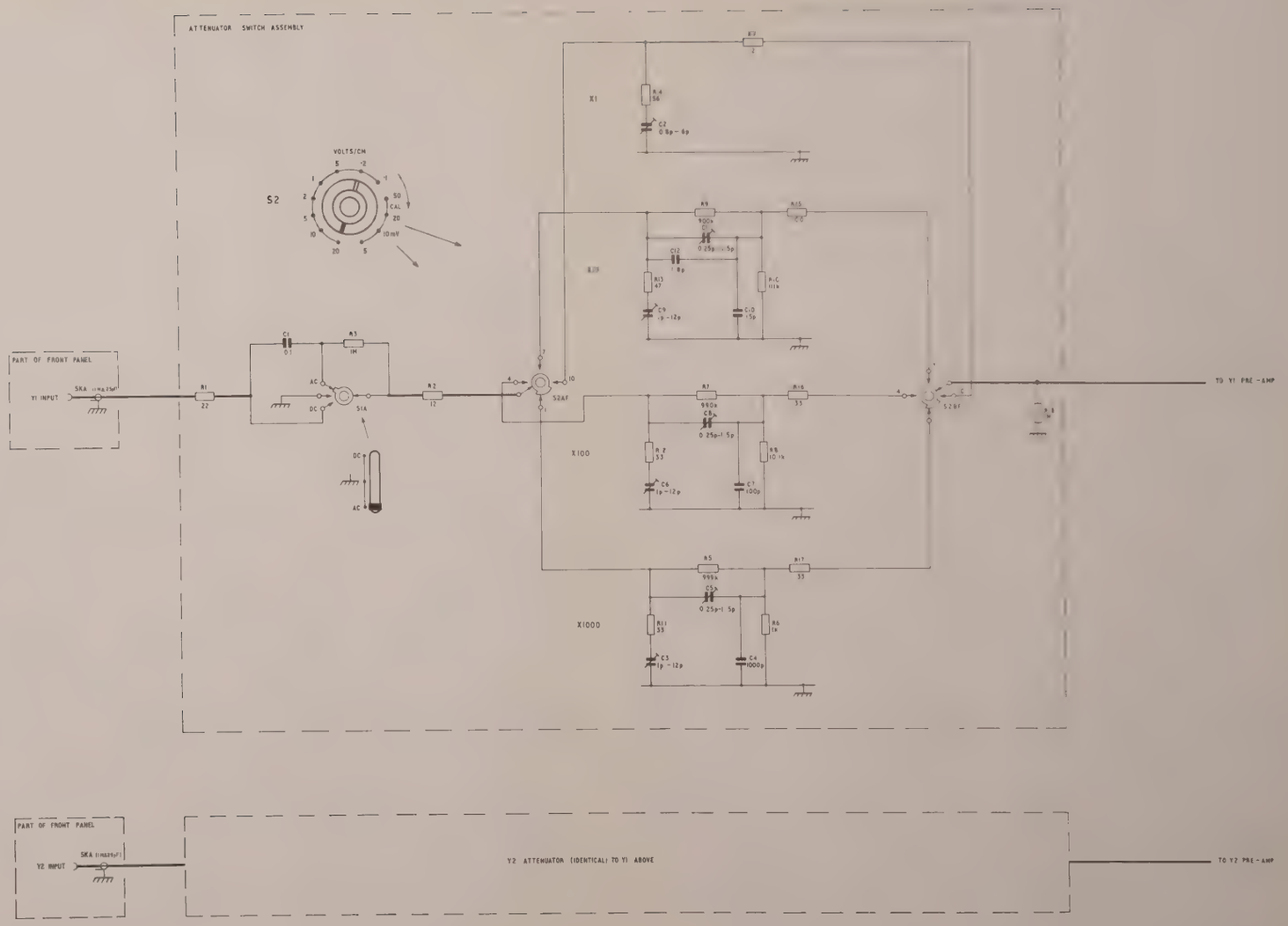


Fig. 9.4 Attenuators (DA1017001)

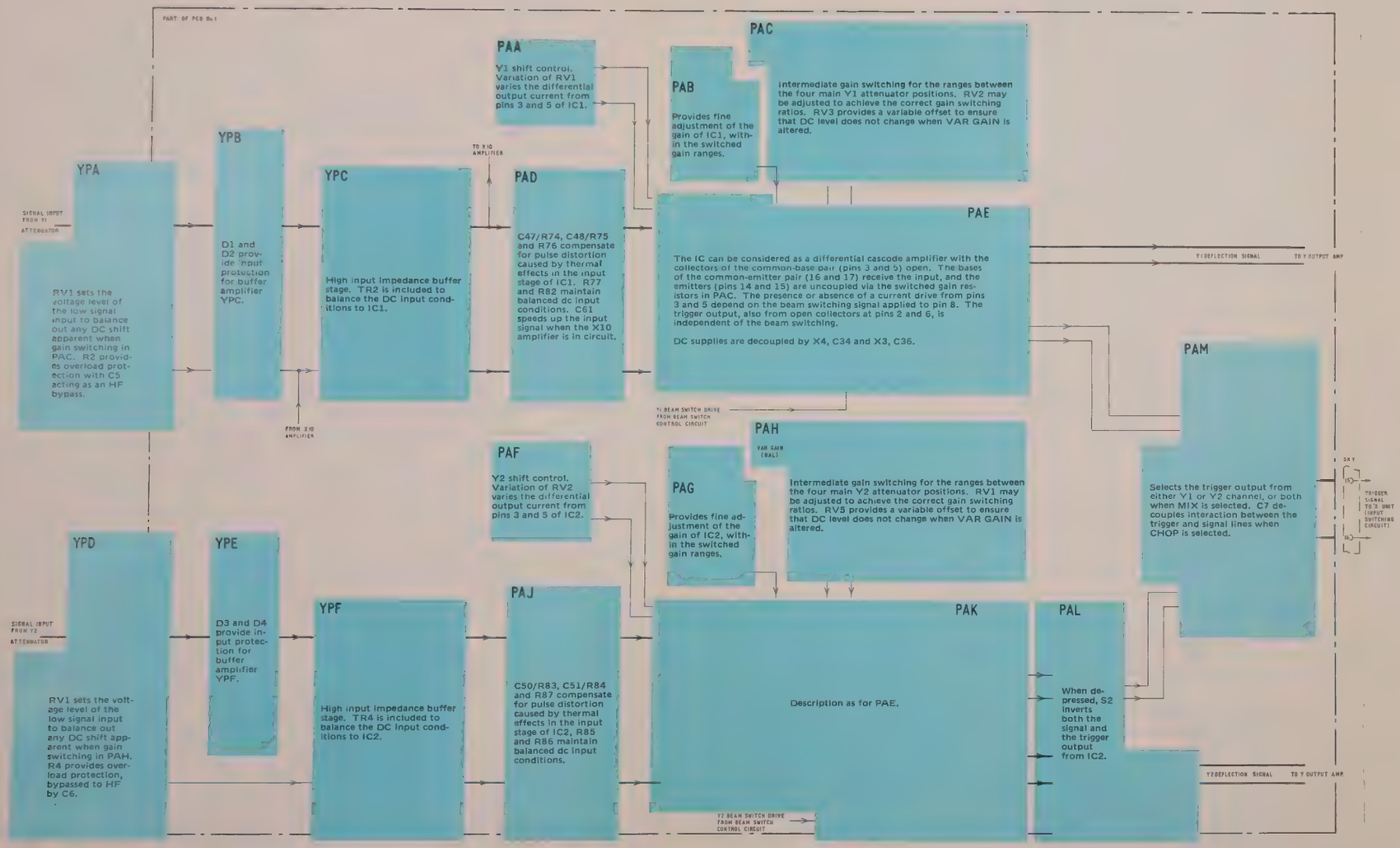

PART OF PCB No 1
PAA
Y1 shift control. Variation of RV1 varies the differential output current from pins 3 and 5 of IC1.
PAB
Provides fine adjustment of the gain of IC1, within the switched gain ranges.
PAC
Intermediate gain switching for the ranges between the four main Y1 attenuator positions. RV2 may be adjusted to achieve the correct gain switching ratios. RV3 provides a variable offset to ensure that DC level does not change when VAR GAIN is altered.
YPA
SIGNAL INPUT FROM Y1 ATTENUATOR
RV1 sets the voltage level of the low signal input to balance out any DC shift apparent when gain switching in PAC. R2 provides overload protection with C5 acting as an HF bypass.
YPB
D1 and D2 provide input protection for buffer amplifier YPC.
TO X10 AMPLIFIER
FROM X10 AMPLIFIER
YPC
High input impedance buffer stage. TR2 is included to balance the DC input conditions to IC1.
PAD
C47/R74, C48/R75 and R76 compensate for pulse distortion caused by thermal effects in the input stage of IC1. R77 and R82 maintain balanced dc input conditions. C61 speeds up the input signal when the X10 amplifier is in circuit.
PAE
The IC can be considered as a differential cascode amplifier with the collectors of the common-base pair (pins 3 and 5) open. The bases of the common-emitter pair (16 and 17) receive the input, and the emitters (pins 14 and 15) are uncoupled via the switched gain resistors in PAC. The presence or absence of a current drive from pins 3 and 5 depend on the beam switching signal applied to pin 8. The trigger output, also from open collectors at pins 2 and 6, is independent of the beam switching.
DC supplies are decoupled by X4, C34 and X3, C36.
Y1 DEFLECTION SIGNAL
TO Y OUTPUT AMP
Y1 BEAM SWITCH DRIVE FROM BEAM SWITCH CONTROL CIRCUIT
PAM
Selects the trigger output from either Y1 or Y2 channel, or both when MIX is selected. C7 decouples interaction between the trigger and signal lines when CHOP is selected.
SK Y
TRIGGER SIGNAL TO T. UNIT (INPUT SWITCHING CIRCUIT)
PAH
VAR GAIN (BAL)
PAG
Provides fine adjustment of the gain of IC2, within the switched gain ranges.
Intermediate gain switching for the ranges between the four main Y2 attenuator positions. RV1 may be adjusted to achieve the correct gain switching ratios. RV5 provides a variable offset to ensure that DC level does not change when VAR GAIN is altered.
PAF
Y2 shift control. Variation of RV2 varies the differential output current from pins 3 and 5 of IC2.
YPD
SIGNAL INPUT FROM Y2 ATTENUATOR
RV1 sets the voltage level of the low signal input to balance out any DC shift apparent when gain switching in PAH. R4 provides overload protection, bypassed to HF by C6.
YPE
D3 and D4 provide input protection for buffer amplifier YPF.
YPF
High input impedance buffer stage. TR4 is included to balance the DC input conditions to IC2.
PAJ
C50/R83, C51/R84 and R87 compensate for pulse distortion caused by thermal effects in the input stage of IC2, R85 and R86 maintain balanced dc input conditions.
PAK
Description as for PAE.
PAL
When depressed, S2 inverts both the signal and the trigger output from IC2.
Y2 DEFLECTION SIGNAL
TO Y OUTPUT AMP
Y2 BEAM SWITCH DRIVE FROM BEAM SWITCH CONTROL CIRCUIT

Fig. 9.5 Pre-amplifiers Block Diagram

Procedure 101 Cal 1

Step attenuator and variable gain balancing.

The procedures for Y1 and Y2 attenuators are identical; where applicable, Y2 adjustments are in brackets.

1. Obtain a single line trace on Y1 (Y2) channel.
2. Set Y1 (Y2) sensitivity selector to 20mV/cm and adjust Y1 (Y2) shift to centralise the trace vertically.
3. Set sensitivity selector to 50mV/cm and adjust Y1 BAL (Y2 BAL) preset control RV1 to re-centre the trace.
4. Re-adjust BAL control, as necessary, so that the trace does not shift when the sensitivity selector is changed between 20mV/cm and 50mV/cm.
5. Adjust RV3 (RV5) on pcb No. 1 to obtain minimum vertical shift as the trace position variable gain control is rotated over its full range. Trace movement when balanced should be less than 2mm.
6. Repeat above adjustments for Y2.

Procedure 101 Cal 3

Gain ratio adjustment.

Procedures for Y1 and Y2 are identical; adjustments for Y2 are given in brackets.

1. Set Y1 (Y2) variable gain control to CAL. Set sensitivity to 0.2V/cm.
2. Inject a 1kHz signal of 1V amplitude from Bradley 192 or 156 into Y1 (Y2) input.
3. Adjust Y1 CAL (Y2 CAL) preset control for a 5cm picture.
4. Reduce the input signal to 250mV. Change the sensitivity to 50mV/cm.
5. Adjust RV2 (RV4) on pcb No. 1 for a 5cm picture.
6. Repeat paras. 1 - 5 until both sensitivities are within specification.
7. Repeat paras. 1-6 for Y2.

Procedure 101 Cal 4

Y amplifier gain.

1. On timebase unit, set TIME/CM to XY and trigger selector to INT. On A101, select Y2 mode and Y1 trigger; the instrument is now set up for XY operation with the horizontal signal on the Y1 input and the vertical signal on Y2 input.
2. Set Y1 sensitivity to 5mV/cm and apply 1kHz at 30mV from Bradley 192 or 156 or from the internal calibrator. Two horizontally opposed spots will now be displayed.
3. Adjust Y1 shift for minimum horizontal movement of spots when trigger coupling switch on timebase is moved between AC and DC.

4. Adjust Y1 CAL preset control to position the spots 6cm apart.

5. Switch TIME/CM to 0.5ms; select Y1 mode on A101.

6. Adjust RV7 (shown on circuit diagram Fig. 9.14) on A101 pcb No. 1 for a 6cm picture.

7. Transfer 30mV input signal to Y2 input. Set Y2 sensitivity to 5mV/cm and fine gain control to CAL.

8. Adjust Y2 CAL preset control for a 6 cm picture.

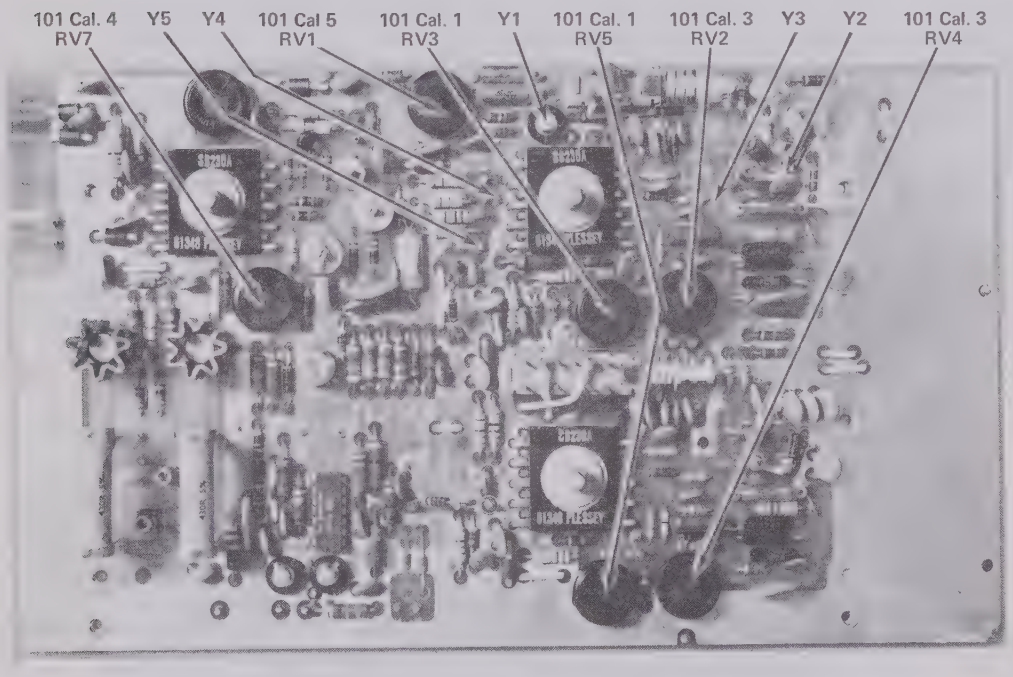


Fig. 9.6 PCB no. 1 (Attenuators, Switches and Heatsinks Removed)

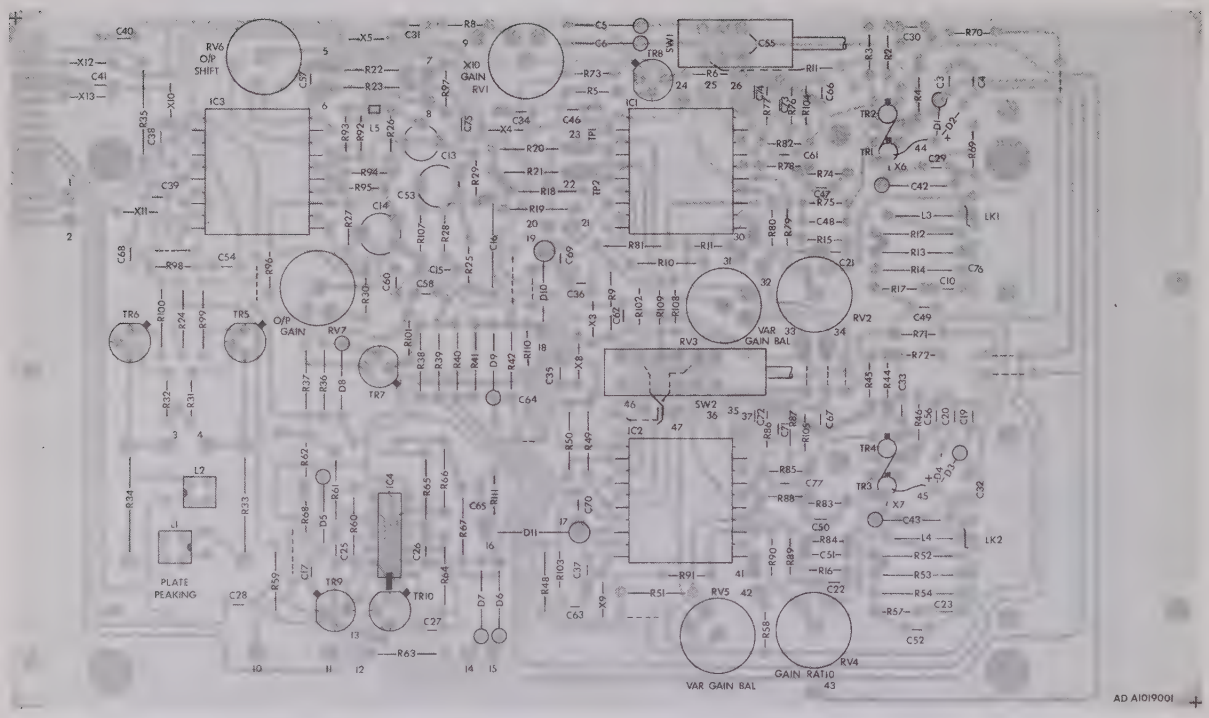


Fig. 9.7 PCB no. 1 (Component Side)

Procedure 101 Cal 5

X10 amplifier gain.

1. Set Y1 sensitivity to 5mV/cm and variable gain control to CAL. Inject 30mV signal into Y1 input from Bradley 192 or 156.

2. Adjust Y1 shift to position trace on the centre 6cm of screen.

3. Reduce input signal to 3mV, select X10.

4. Adjust RV1 on pcb No. 1 to obtain a 6cm picture.

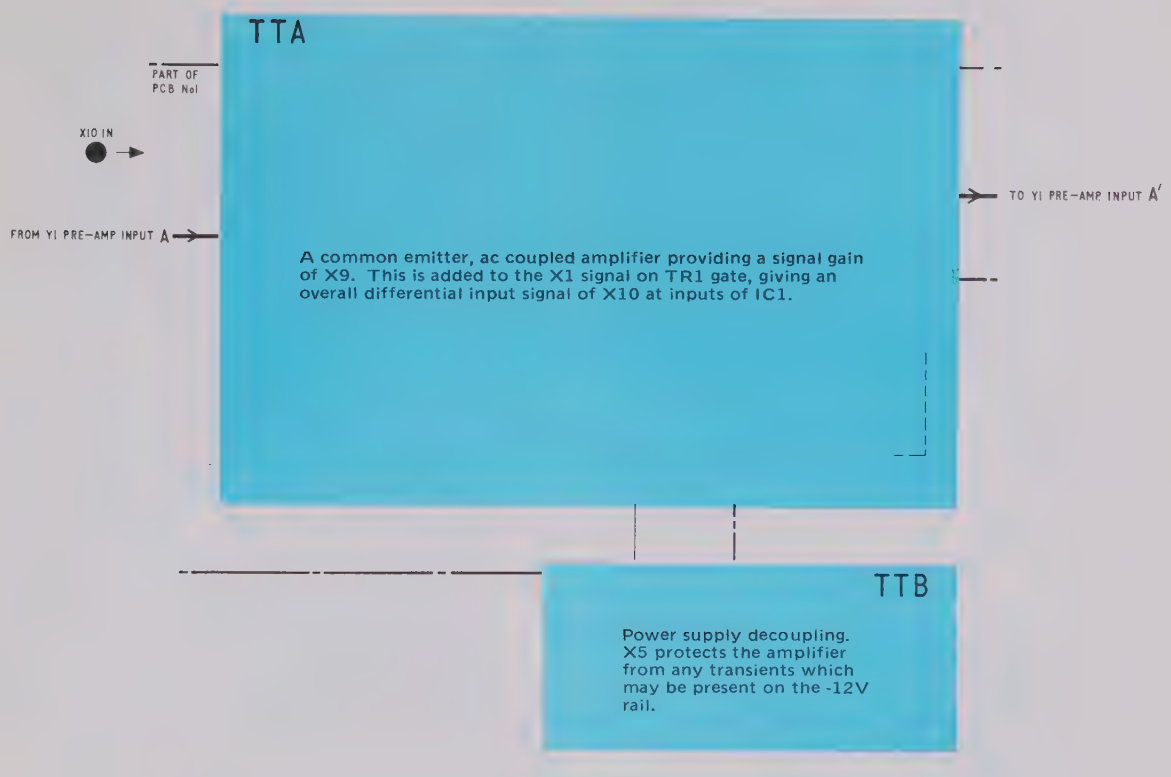

TTA
PART OF PCB No1
X10 IN
FROM Y1 PRE-AMP INPUT A
TO Y1 PRE-AMP INPUT A'
A common emitter, ac coupled amplifier providing a signal gain of X9. This is added to the X1 signal on TR1 gate, giving an overall differential input signal of X10 at inputs of IC1.
TTB
Power supply decoupling. X5 protects the amplifier from any transients which may be present on the -12V rail.

Fig. 9.8 Times Ten Amplifier Block Diagram

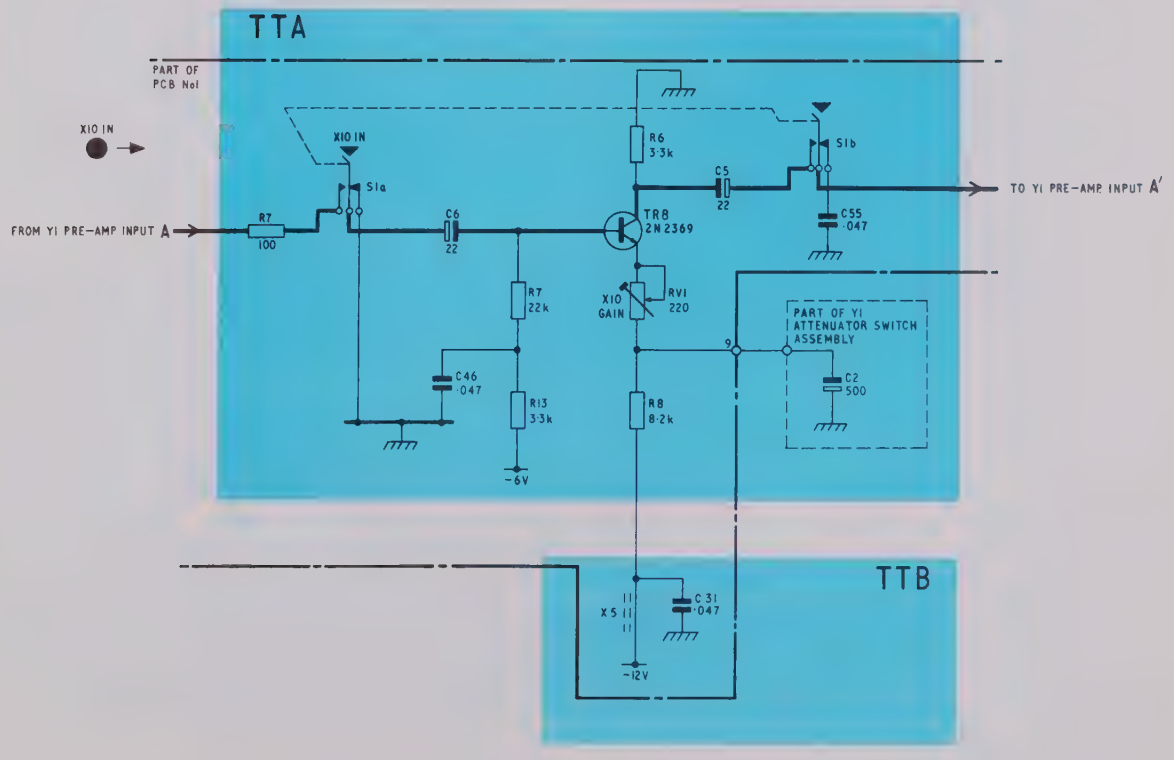


Fig. 9.9 Times Ten Amplifier (CA1017003)

Table 9.2 Test Information Points Y1 to Y5 - Pre-amplifiers

Point	DC Level	Voltage peak-to-peak	Remarks
Y1	-2.09V	25mV	Reduce input signal to 30mV and select X10 for this measurement.
Y2	0V	30mV	
Y3	+1.38V	30mV	
Y4	-0.47V	25mV	
Y5 (TP2)	-0.52V	Not significant (current drive)	

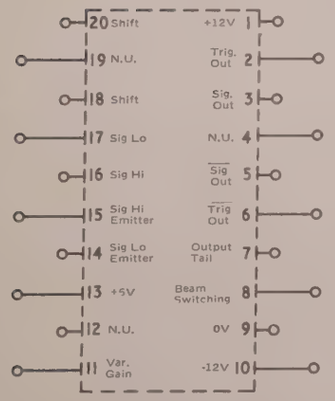
Circuit Notes

Disconnect pin no. 2 of pcb no. 2

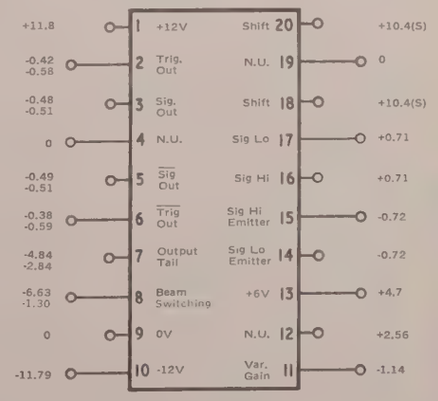
Edge connector no. 5 of pcb no. 2

Test information point

Typical voltage measurements at the pins of IC1 and IC2 are shown below. All measurements were made with standard front panel settings (see page 9.2) using a high impedance (10MΩ) digital voltmeter. Where two figures are given, the upper shows the reading when the channel containing that IC is selected, the lower when it is not selected. The suffix (S) denotes that the reading is dependent on the position of the shift control for the channel in use.



Copper Side



Component Side

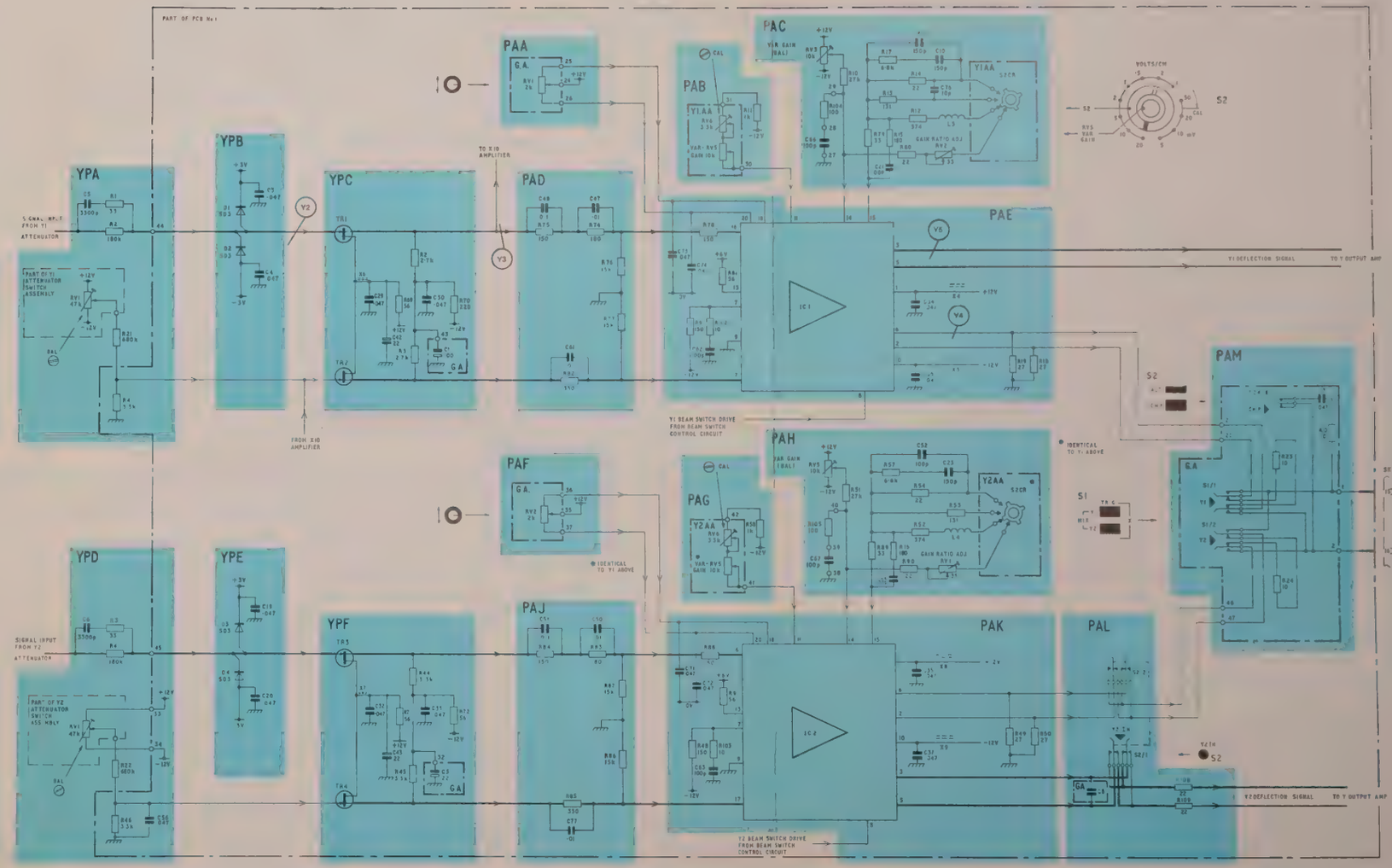


Fig. 9.10 Pre-amplifiers (DA1017002)

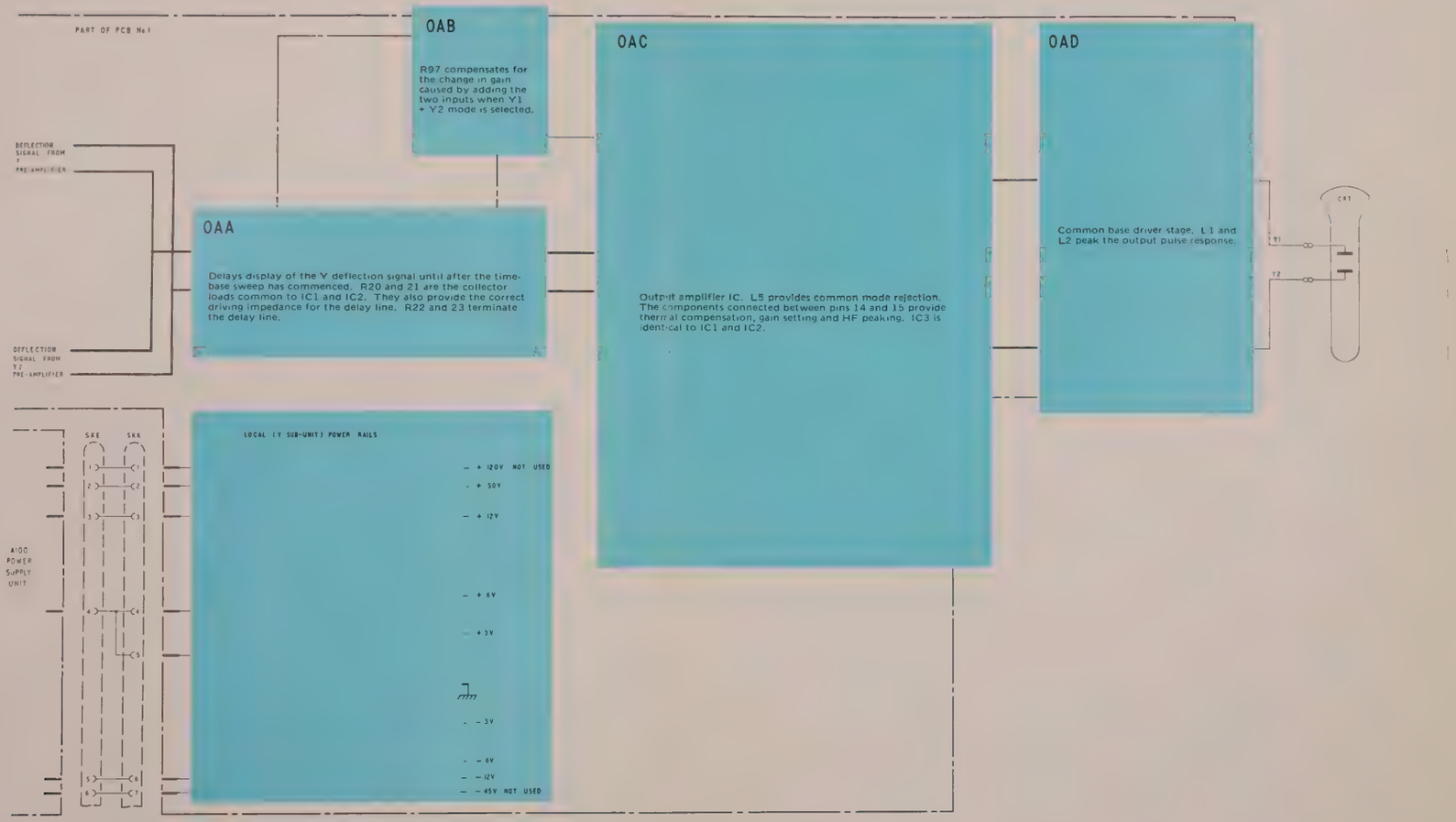

PART OF PCB No 1
0AB
R97 compensates for the change in gain caused by adding the two inputs when Y1 + Y2 mode is selected.
0AC
Output amplifier IC. L5 provides common mode rejection. The components connected between pins 14 and 15 provide thermal compensation, gain setting and HF peaking. IC3 is identical to IC1 and IC2.
0AD
Common base driver stage. L1 and L2 peak the output pulse response.
CRT
Y1
Y2
DEFLECTION SIGNAL FROM Y PRE-AMPLIFIER
DEFLECTION SIGNAL FROM Y2 PRE-AMPLIFIER
0AA
Delays display of the Y deflection signal until after the time-base sweep has commenced. R20 and 21 are the collector loads common to IC1 and IC2. They also provide the correct driving impedance for the delay line. R22 and 23 terminate the delay line.
A100 POWER SUPPLY UNIT
SKE
SKK
LOCAL (Y SUB-UNIT) POWER RAILS
+ 120V NOT USED
+ 50V
+ 12V
+ 6V
+ 3V
- 3V
- 6V
- 12V
- 45V NOT USED

Fig. 9.11 Output Amplifier and Local Supplies Block Diagram

Procedure 101 Cal 2

Output amplifier centering.

1. Obtain a single line trace.
2. Connect a shorting link between TP1 and TP2.
3. Adjust RV6 on pcb No. 1 to centralise the trace vertically.
4. Remove shorting link.

Procedure 101 Cal 7

HF pulse response.

1. Apply a 1MHz fast-rise signal from the Tektronix 106 to the Y1 input via a 50Ω co-axial cable terminated by a 50Ω in-line termination. Select Y1 mode and Y1 trigger.
2. Set TIME/CM to 0.5μs and Y1 sensitivity to 20mV/cm. Adjust generator output for a 6cm picture.
3. Adjust C53 for an approximately square leading edge.
4. Adjust C14 for a flat top to the trace.
5. Set TIME/CM to 0.1μs. Adjust C13 for a flat top to the first 100ns (1cm) following the leading edge.
6. Re-adjust C53 for optimum leading edge. Aberrations should not now exceed 1.5mm p-p
7. Transfer the generator to Y2. Select Y2 mode. The trace should be similar to Y1 trace in para. 6, with aberrations not exceeding 2mm.
8. Disconnect the square-wave generator, and connect the Tektronix 191 constant-amplitude generator, using the same co-axial cable and termination. Set the generator output for a trace of 8cm amplitude at 50kHz.
9. Increase the generator frequency until the trace amplitude reduces to 5.6cm. This frequency should be at least 35MHz under normal ambient conditions, which will ensure that the specified 30MHz bandwidth is obtained under extreme conditions.
10. Repeat paras. 8 and 9 for sensitivities of 5, 10, 50, 100, 200 and 500mV/cm.

Note **Adjustment of output amplifier gain (RV7)**

This is an integral part of the overall gain setting procedure. See procedure 101 Cal 4 on pages 9.6 and 9.7.

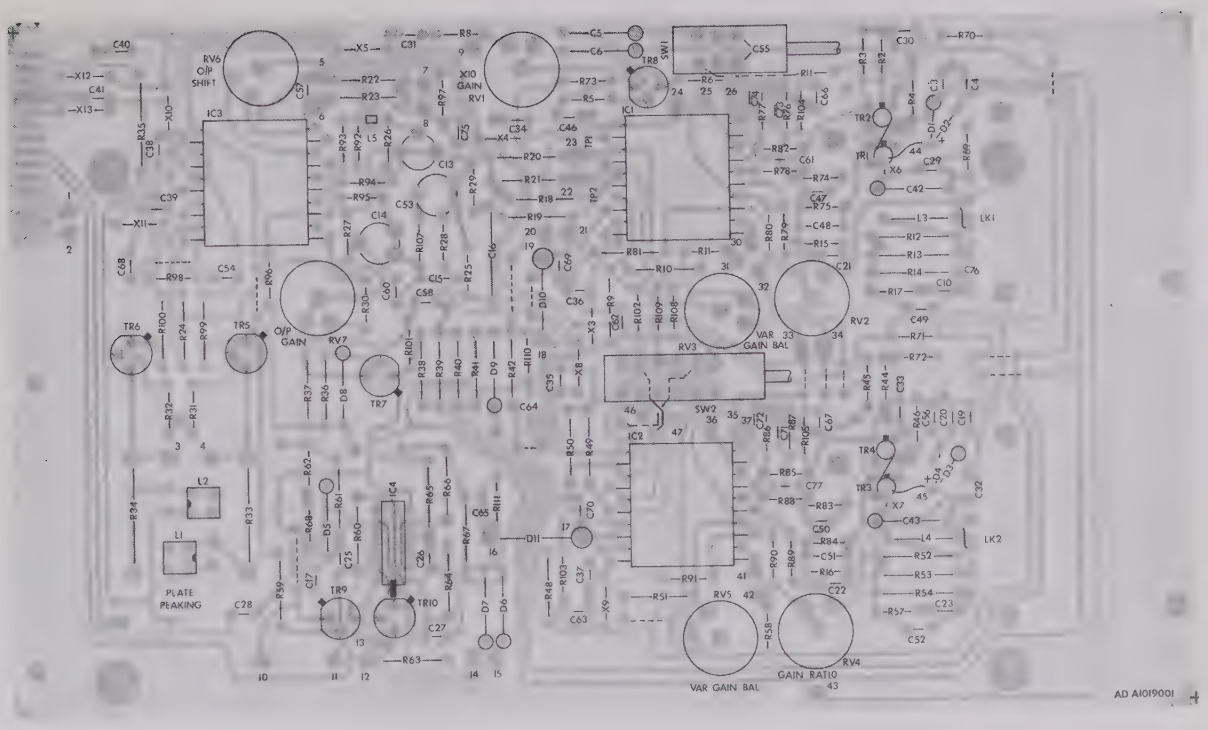


Fig. 9.12 PCB no. 1 (Component Side)

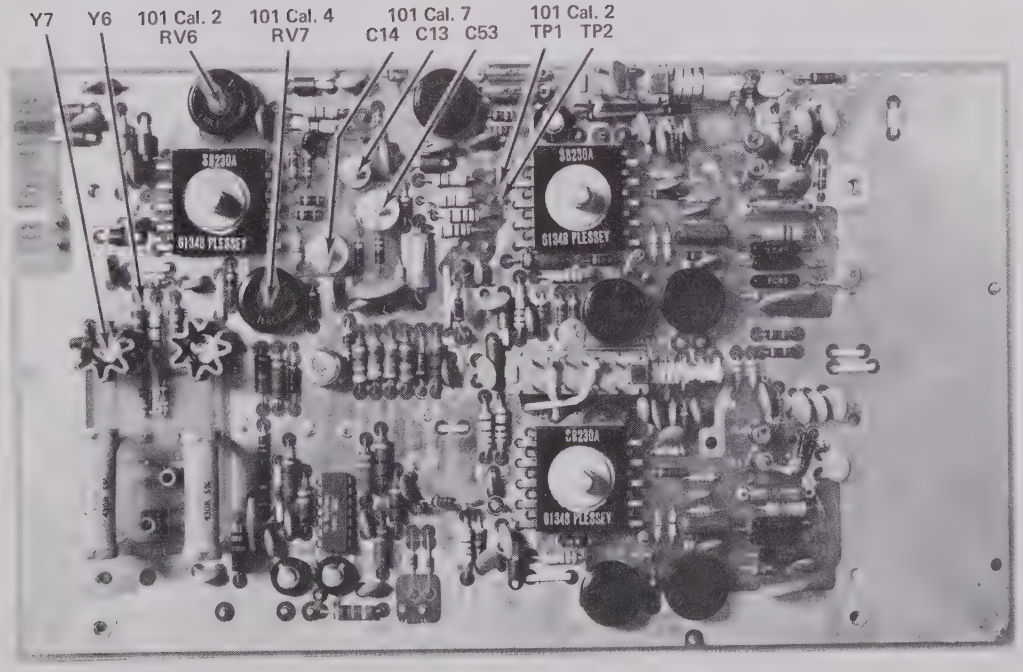


Fig. 9.13 PCB no. 1 (Attenuators, Switches and Heatsinks Removed)

Table 9.3 Test Information Points Y5 to Y7 - Output Amplifier

Point	DC Level	Voltage peak-to-peak	Remarks
Y5	-0.52V	Not significant (current drive)	
Y6	-0.68V	Not significant (current drive)	
Y7	+19V	13V(nom.)	Amplitude depends on CRT Y-plate sensitivity, and may vary between 12 and 14V.

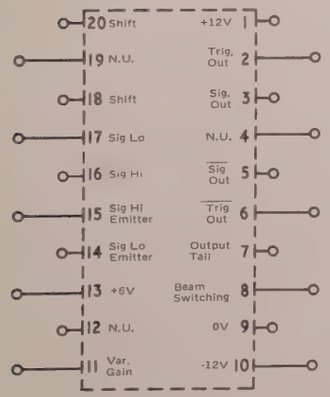
Circuit Notes

Disconnect pin no. 2 of pcb no. 2

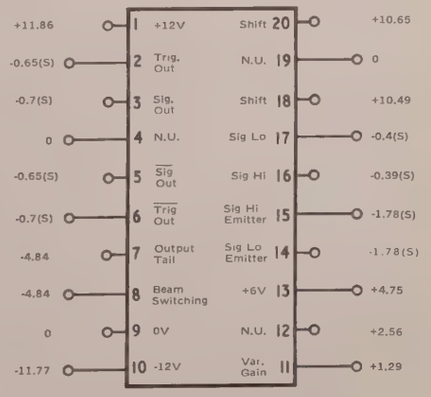
Edge connector no. 5 of pcb no. 2

Test information point

Typical voltage measurements at the pins of IC3 are shown below. All measurements were made with standard front panel settings (see page 9.2) using a high impedance (10MΩ) digital voltmeter. Where a reading is suffixed (S), this denotes that the reading is dependent on the position of the shift control for the channel in use.



Copper Side



Component Side

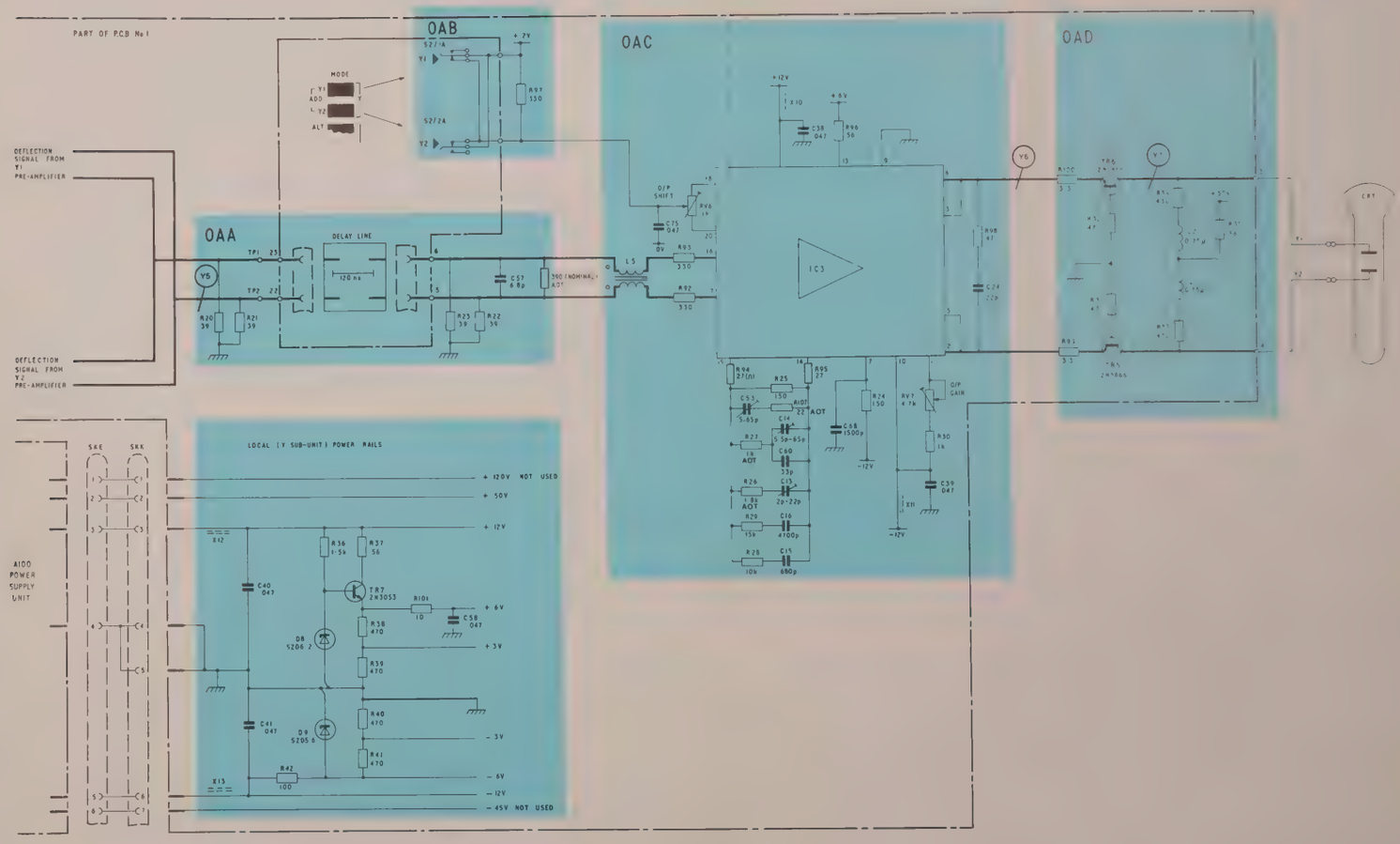


Fig. 9.14 Output Amplifier and Local Supplies (DA1007005)

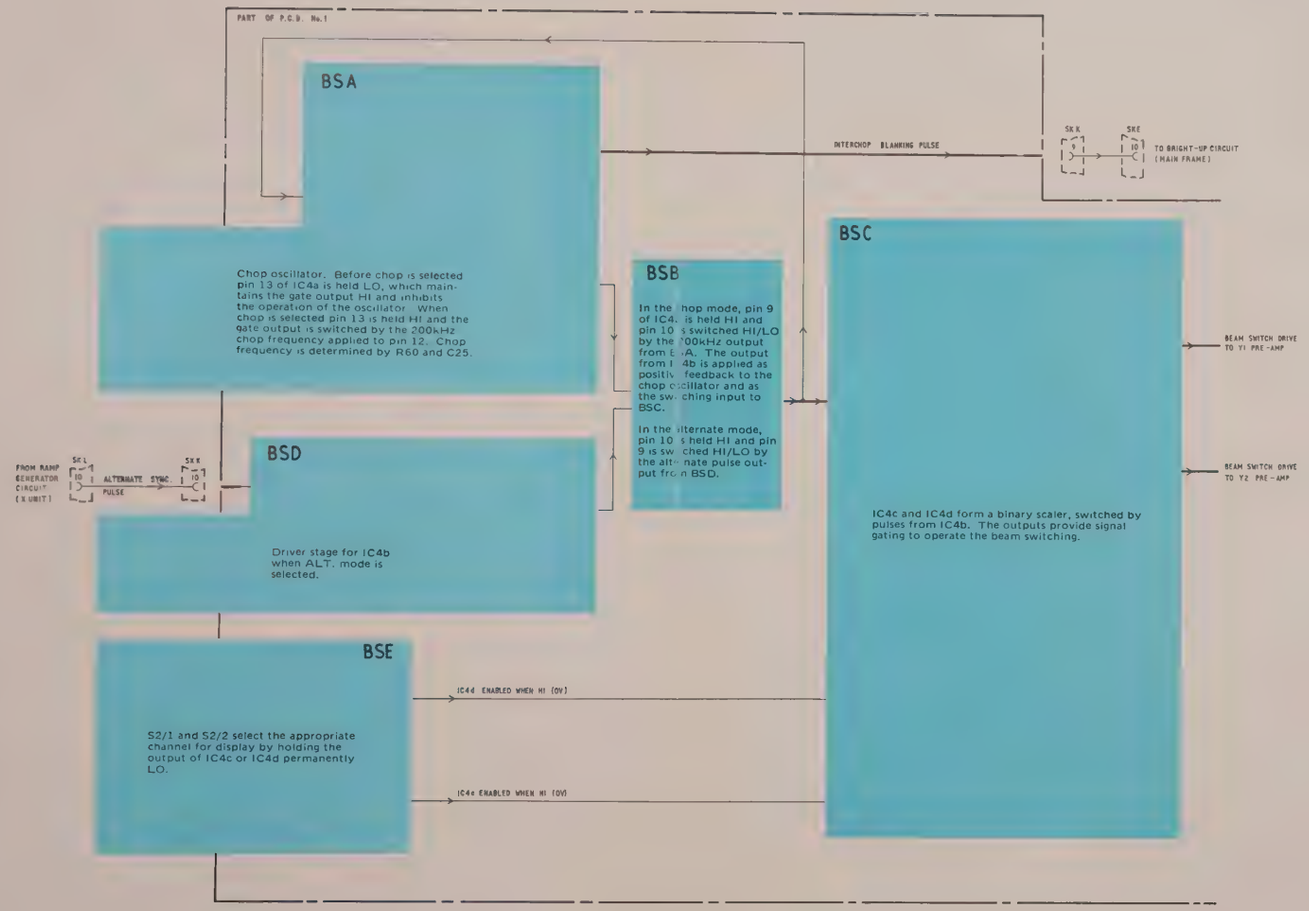

PART OF P.C.B. No.1
BSA
Chop oscillator. Before chop is selected pin 13 of IC4a is held LO, which maintains the gate output HI and inhibits the operation of the oscillator. When chop is selected pin 13 is held HI and the gate output is switched by the 200kHz chop frequency applied to pin 12. Chop frequency is determined by R60 and C25.
INTERCHOP BLANKING PULSE
SK K
SK E
TO BRIGHT-UP CIRCUIT (MAIN FRAME)
BSB
In the chop mode, pin 9 of IC4. is held HI and pin 10 is switched HI/LO by the 200kHz output from IC4A. The output from IC4b is applied as positive feedback to the chop oscillator and as the switching input to BSC.
In the alternate mode, pin 10 is held HI and pin 9 is switched HI/LO by the alternate pulse output from BSD.
BSC
IC4c and IC4d form a binary scaler, switched by pulses from IC4b. The outputs provide signal gating to operate the beam switching.
BEAM SWITCH DRIVE TO Y1 PRE-AMP
BEAM SWITCH DRIVE TO Y2 PRE-AMP
FROM RAMP GENERATOR CIRCUIT (X UNIT)
SK L
SK K
ALTERNATE SYNC. PULSE
BSD
Driver stage for IC4b when ALT. mode is selected.
BSE
S2/1 and S2/2 select the appropriate channel for display by holding the output of IC4c or IC4d permanently LO.
IC4d ENABLED WHEN HI (0V)
IC4c ENABLED WHEN HI (0V)

Fig. 9.15 Beamswitch Block Diagram

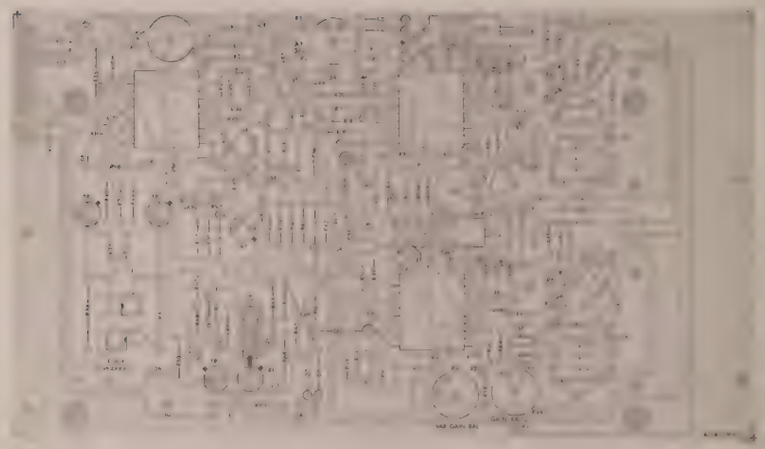


Fig. 9.16 PCB No.1 (Component Side)

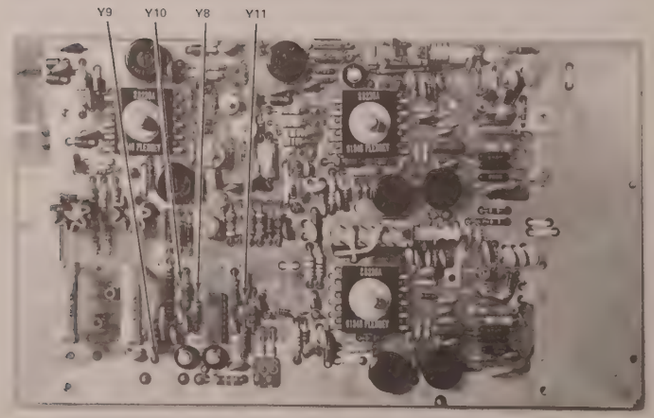


Fig. 9.17 PCB No.1 (Attenuators, Switches and Heatsinks Removed)

Table 9.4 Test Information points Y8 to Y11 - Beam Switch.

Point	Measurement at Standard Settings	Remarks
Y8	− 2V − 6V	Select 'chop' to display these waveforms.
Y9	− 4·8V − 9V	
Y10	0V − 5V	
Y11	0V − 5V	Beam switching drive to IC1.

Detailed description of the chop oscillator

The chop oscillator consists of TR9, IC4a and their associated passive components, and IC4b. IC4b also passes the alternate sync pulse when operating in the ALT mode.

Examination of the DC conditions prevailing in this circuit will show that there is no stable state

1. Assume the output (IC4b pin 8) is HI, at about -1V. This results in TR9 conducting, therefore its collector is at -5V, which is the logical LO in this circuit. This takes IC4a output HI, so IC4b output should be LO.

2. Assume the output is LO, the same reasoning applies, so that the output should be HI.

3. These anomalies can be solved if TR9 has some means of 'holding on' to a HI or LO as required. This is provided, for a short length of time, by the CR circuit C25 and R60, which either draw current from TR9 base or supply it. D5 is an isolating diode, which enables the output of IC4a to rise sharply while the junction of C25, R61 rises more slowly.

Circuit Notes

Disconnect pin no. 2 of pcb no. 2

Edge connector no. 5 of pcb no. 2

Test information point

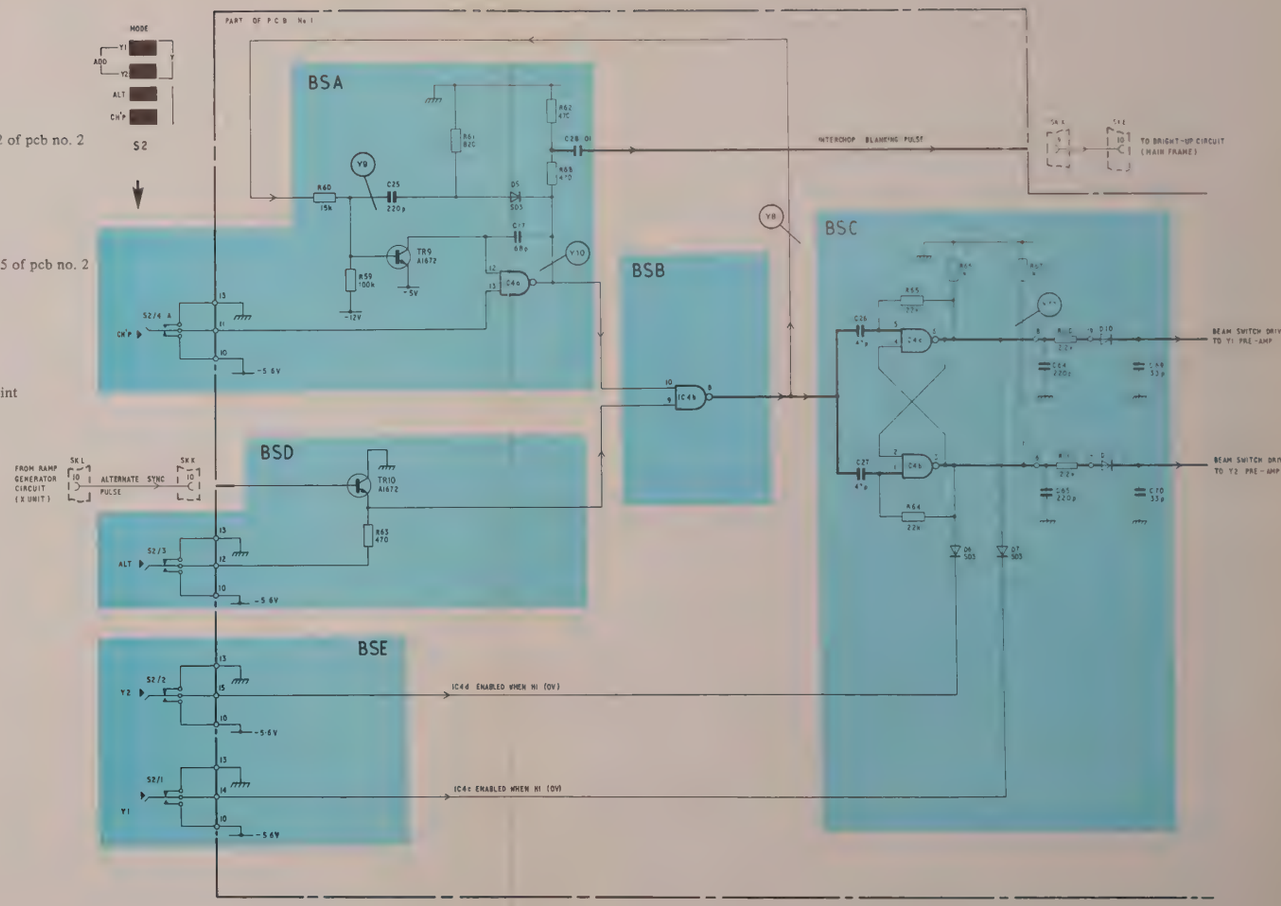


Fig. 9.18 Beam Switch (DA1017004)

COMPONENT PARTS LIST

ABBREVIATIONS

Circuit References

B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

Component Composition

FIXED RESISTORS

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Component Composition (Cont'd)

VARIABLE RESISTORS

Wirewound Preset Single Turn	WWPS
Wirewound Preset Multiturn	WWPM
Wirewound Front Panel Single Turn	WWFS
Wirewound Front Panel Multiturn	WWFM
Carbon Preset Single Turn	CAPS
Carbon Preset Multiturn	CAPM
Carbon Front Panel Single Turn	CAFS
Carbon Front Panel Multiturn	CAFM
Cermet Preset Single Turn	CMPS
Cermet Preset Multiturn	CMPM
Cermet Front Panel Single Turn	CMFS
Cermet Front Panel Multiturn	CMFM

CAPACITORS

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Column 4 indicates rating (Watts or Volts)
Column 5 indicates tolerance (%)

Component Parts List for General Assembly

Cct. Ref.	General Description				Solartron Part No.
R1	CACP	33	.125	10	172013300
R2	CACP	180k	.25	10	172351800
R3	CACP	33	125	10	172013300
R4	CACP	180k	.25	10	172351800
R5	MEOX	680k	.5	1	195456800
R6	MEOX	680k	.5	1	195456800
R7	CACP	100	.125	10	172021000
R8	CACP	10	.125	10	172011000
R9	CACP	.125	10	10	172011000
R10	CACP	.125	10	10	172011000
RV1	WWPM	0.5	2k	20	110025120
RV2	WWPM	0.5	2k	20	110025120
C1	ALME	12V	100	+100 -20	270481000
C2	ALME	12V	500	+100 -20	270485000
C3	TAND	15V	22	20	208700015
C5	CERM	500V	3300p	20	241333300
C6	CERM	500V	3300p	20	241333300
C7	CERM	25V	.047	+50 -25	241944700
C8	CERM	500V	15p	20	241311500

Component Parts List for Attenuator Assembly

Cct Ref.	General Description				Solartron Part No.
R1	CACP	22	.125	10	172012200
R2	CACP	12	.125	10	172011200
R3	CACP	1M	.125	10	172061000
R4	CACP	12	.125	10	172011200
R5	MEFM	999k	.5	.5	A17410012
R6	MEFM	1k	.25	.5	A17410013
R7	MEFM	990k	.5	.5	A17410021
R8	MEFM	10.1k	.25	.5	A17410022
R9	MEFM	900k	.5	.5	A17410023
R10	MEFM	111k	.25	.5	A17410024
R11	CACP	33	.125	10	172013300
R12	CACP	33	.125	10	172013300
R13	CACP	47	.125	10	172014700
R14	CACP	56	.125	10	172015600
R15	CACP	100	.125	10	172021000
R16	CACP	33	.125	10	172013300
R17	CACP	33	.125	10	172013300
R18	MEFM	1M	.5	.5	A17410029
RV1	Res. Var.	47k	.25	20	119600301
RV5	Res. Var.	10k	.25	20	119600201
RV6	Res. Var.	3.3k	.25	20	119600401

Cct Ref.	General Description				Solartron Part No.
C1	ESTM	0.1	400	10	226051000
C2	CERM	0.8-6p	400		290030210
C3	CERM	1-12p	400		190030200
C4/ C5	MICA	1.25/ 1000p	250		290030230
C6	CERM	1-12p	400		290030200
C7/ C8	MICA	1.25/ 100p	250	10	290030200
C9	CERM	1-12p	400		290030200
C10/ C11	MICA	1.25/ 15p	250		290030250
C12	CERM	1.8p	750	10	240001800

Component Parts List

for

PCB No.1 (A101900l)

Cct. Ref.	General Description				Solartron Part No.
R2	MEOX	2.7k	.25	1	195332700
R3	MEOX	2.7k	.25	1	195332700
R4	MEOX	3.3k	.25	1	195333300
R5	CACP	22k	.125	10	172042200
R6	CACP	3.3k	.125	10	172042200
R8	CACP	8.2k	.125	10	172031000
R9	MEOX	150	.5	5	193521500
R10	MEOX	27k	.5	5	193542700
R11	CACP	1k	.125	10	172031000
R12	MEFM	374	.25	0.5	160400471
R13	MEFM	131	.25	0.5	160400472
R14	MEFM	22	.25	0.5	160400473
R15	CACP	180	.125	10	172021800
R16	CACP	180	.125	10	172014700
R17	CACP	6.8k	.125	10	172036800
R18	MEOX	27	.5	1	195412700
R19	MEOX	27	.5	1	195412700
R20	MEOX	39	.5	1	195413900
R21	MEOX	39	.5	1	195413900
R22	MEOX	39	.5	1	195413900
R23	MEOX	39	.5	1	195413900
R24	MEOX	150	.5	5	193521500
R25	MEOX	150	.25	5	195621500
R26	CACP	1.8k	.125	10	172031800
R27	MEOX	1k	.25	5	195631000
R28	CACP	10k	.125	10	172041000
R29	CACP	15k	.125	10	172041500
R30	CACP	1k	.125	10	172031000
R31	CACP	47	.125	10	172014700
R32	CACP	47	.125	10	172014700
R33	MEOX	430	6	5	160500020
R34	MEOX	430	6	5	160500020
R35	MEOX	56	1	5	193415600
R36	CACP	1.5k	.25	10	172331500
R37	CACP	56	.25	10	172315600
R38	CACP	470	.25	10	172324700
R39	CACP	470	.25	10	172324700
R40	CACP	470	.25	10	172324700
R41	CACP	470	.25	10	172324700
R42	CACP	100	.25	10	172321000
R44	MEOX	3.3k	.25	1	195333300
R45	MEOX	3.3k	.25	1	195333300
R46	MEOX	3.3k	.25	1	195333300
R48	MEOX	150	.5	5	193521500

Cct. Ref.	General Description				Solartron Part No.
R49	MEOX	27	.5	1	195412700
R50	MEOX	27	.5	1	195412700
R51	MEOX	27k	.5	5	193542700
R52	MEFM	374	.25	.5	160400471
R53	MEFM	131	.25	.5	160400472
R54	MEFM	22	.25	.5	160400473
R57	CACP	6.8	.125	10	172036800
R58	CACP	1k	.125	10	172031000
R59	CACP	100k	.25	10	172351000
R60	CACP	15k	.25	10	172341500
R61	CACP	820	.25	10	172328200
R62	CACP	470	.125	10	172024700
R63	CACP	470	.25	10	172324700
R64	CACP	22k	.25	10	172342200
R65	CACP	22k	.25	10	172342200
R66	CACP	1k	.25	10	172331000
R67	CACP	1k	.25	10	172331000
R68	CACP	470	.125	10	172024700
R69	CACP	56	.125	10	172015600
R70	CACP	220	.125	10	172022200
R71	CACP	56	.125	10	172015600
R72	CACP	56	.125	10	172015600
R73	CACP	3.3k	.125	10	172033300
R74	MEOX	180	.25	5	195621800
R75	MEOX	150	.25	5	195621500
R76	MEOX	15k	.25	5	195641500
R77	MEOX	15k	.25	5	195641500
R78	CACP	150	.125	10	172021500
R79	MEOX	33	.25	5	195613300
R80	MEOX	22	.25	5	195612200
R81	CACP	56	.25	10	172315600
R82	MEOX	330	.25	5	195623300
R83	MEOX	180	.25	5	195621800
R84	MEOX	150	.25	5	195621500
R85	MEOX	330	.25	5	195623300
R86	MEOX	15k	.25	5	195641500
R87	MEOX	15k	.25	5	195641500
R88	CACP	150	.125	10	172021500
R89	MEOX	33	.25	5	195613300
R90	MEOX	22	.25	5	195612200
R91	CACP	56	.125	10	172015600
R92	CACP	330	.125	10	172023300
R93	CACP	330	.125	10	172023300
R94	CACP	27	.125	10	172012700
R95	CACP	27	.125	10	172012700
R96	CACP	56	.125	10	172015600
R97	CACP	330	.125	10	172023300
R98	CACP	47	.125	10	172014700
R99	CACP	3.3	.5	10	160100107
R100	CACP	3.3	.5	10	160100107
R101	CACP	10	.125	10	172011000
R102	CACP	10	.125	10	172011000
R103	CACP	10	.125	10	172011000
R104	CACP	100	.125	10	172021000
R105	CACP	100	.125	10	172021000
R107	CACP	22	.125	10	172012200
R108	CACP	22	.125	10	172012200
R109	CACP	22	.125	10	172012200
R110	CACP	2.2k	.125	10	172032200
R111	CACP	2.2k	.125	10	172032200
RV1	CAPS	220	.25	20	136622200
RV2	CAPS	33	.25	20	136613300
RV3	CAPS	10k	.25	20	136641000
RV4	CAPS	33	.25	20	136613300
RV5	CAPS	10k	.25	20	136641000
RV6	CAPS	1k	.25	20	136631000
RV7	CAPS	4.7k	.25	20	136634700

Cct. Ref.	General Description				Solartron Part No.
C3	CERM	.047	25	+50 -25	241944700
C4	CERM	.047	25	+50 -25	241944700
C5	TAND	22	15	20	208700015
C6	TAND	22	15	20	208700015
C10	CERM	150p	500	20	241321500
C13	Trimmer	22p	50		290030180
C14	Trimmer	65p	50		290030190
C15	CERM	680p	500	10	208450116
C16	ESTF	4700p	500	10	221334700
C17	CERM	68p	500	20	241316800
C19	CERM	.047	25	+50 -25	241944700
C20	CERM	.047	25	+50 -25	241944700
C21	CERM	100p	500	20	241321000
C22	CERM	100p	500	20	241321000
C23	CERM	150p	500	20	241321500
C25	CERM	220p	500	20	241322200
C26	CERM	47p	500	20	241314700
C27	CERM	47p	500	20	241314700
C28	CERM	.01	25	+50 -25	241941000
C29 to C41	CERM	.047	25	+50 -25	241944700
C42	TAND	22	15	20	208700015
C43	TAND	22	15	20	208700015
C46	CERM	.047	25	+50 -25	241944700
C47	CERM	.01	25	+50 -25	241941000
C48	ESTM	0.1	100	10	225451000
C49	CERM	150p	500	10	208450117
C50	CERM	.01	25	+50 -25	241941000
C51	ESTM	0.1	100	10	225451000
C52	CERM	100p	500	10	208450115
C53	Trimmer	5/65p	50		290030190
C54	CERM	22p	500	20	241312200
C55	CERM	.047	25	+50 -25	241944700
C56	CERM	.047	25	+50 -25	241944700
C57	CERM	6.8p	500	20	241306800
C58	CERM	.047	25	+50 -25	241944700
C60	CERM	33p	500	20	241313300
C61	CERM	.01	25	+50 -25	241941000
C62	CERM	100p	500	20	241321000
C63	CERM	100p	500	20	241321000
C64	CERM	220p	500	20	241322200
C65	CERM	220p	500	20	241322200
C66	CERM	100p	500	20	241321000
C67	CERM	100p	500	20	241321000
C68	CERM	1500p	500	20	241331500
C69	CERM	33p	500	20	241313300
C70	CERM	33p	500	20	241313300
C71 to C75	CERM	.047	25	+50 -25	241944700
C76	CERM	500V	10p	20	241311000
C77	CERM	25V	.01	+50	241941000

Cct Ref.	General Description	Solartron Part No.
D1	IN3595	300523590
D2	IN3595	300523590
D3	IN3595	300523590
D4	IN3595	300523590
D5	Diode SD3	300522160
D6	Diode SD3	300522160
D7	Diode SD3	300522160
D8	Silicon Zener 6.2V	300521240
D9	Silicon Zener 5.6V	300521450
D10	Diode SD3	300522160
D11	Diode SD3	300522160
TR1/ TR2	Matched F.E.T.'s	300400102
TR3/ TR4	Matched F.E.T.'s	300400102
TR5	2N3866	A17400008
TR6	2N3866	A17400008
TR7	2N3053	300551800
TR8	2N2369	300552390
TR9	A1672	300551910
TR10	A1672	300551910
IC1	Plessey SB230A	519600201
IC2	Plessey SB230A	519600201
IC3	Plessey SB230A	519600201
IC4	846	510000160
L1	Inductor .75mH	309500201
L2	Inductor .75mH	309500201
L3	Inductor .16mH	305020500
L4	Inductor .16mH	305020500
L5	Common Mode Choke	309500602
X3 to X13	Ferrite Bead	309010060
SW1	Switch Push Button	379601001
SW2	Switch Push Button	379600801

SECTION 10 Single Timebase A111

Outline Description (refer to block diagram)

The A111 is a single timebase generator, capable of generating basic triggered or free-running sweeps from 0.1μs/cm to 0.5sec/cm. The sweep speed can be extended to 20ns/cm by the X5 amplifier, and reduced to 1.25sec/cm by the variable sweep speed control.

The trigger source is selected by one of three push-buttons, the signal from the Y module being amplified before selection. The selected signal is passed to a FET input buffer amplifier, which provides a 1MΩ impedance for external trigger and XY plot input signals. If XY is selected, this signal then passes to the output amplifier and thence to the X plates, the intermediate stages being inoperative.

If a timebase speed is selected, the trigger signal passes from the input buffer to the trigger generator. This produces a positive-going edge coincident with the positive or negative-going edge of the triggering signal, depending on the trigger polarity selection. In the absence of a trigger signal, if 'AUTO' is selected, the trigger generator produces a train of pulses to the timebase generator, thus allowing a baseline to be displayed.

The generated positive-going edge is applied to the ramp initiator circuitry, via a patented anti-jitter circuit. This eliminates the jitter which normally occurs when the end of hold-off and the trigger pulse are coincident.

The output of this circuit, via a Schmitt trigger, causes the ramp generator to commence its run-up. The end-of-ramp detector switches over when the ramp reaches a defined voltage level; the output of the end-of-ramp detector, being a rectangular waveform coincident with the ramp, is used to generate the bright-up waveform and the alternate trace sync pulse.

Outline Calibration Procedure

For a full calibration, adjustments should be made in the order given in table 10.1. All adjustable components are mounted on pcb No. 1

Table 10.1 A111 Calibration

Procedure	Description	Test Equipment Required
111 Cal 1	Mean plate potential	1
111 Cal 2	Horizontal gain and LF pulse response.	2
111 Cal 3	Ramp rate	2
111 Cal 4	HF pulse response and Sweep speed check.	2

Test Equipment Requirements

Item	Description	Minimum Specification	Suggested Instrument
1	Multimeter	10kΩ/V	AVO model 8
2	Oscilloscope calibrator		Bradley 192 or 156

Standard Settings

The waveforms and voltages at the measuring points in this module were taken from a serviceable instrument with the controls set as follows:-

TIME/CM	0.5ms
Variable	CAL
X5	OUT
TRIG coupling	AC
Trig polarity	+
Trig source	INT
LEVEL	Central
Display	1kHz 6cm

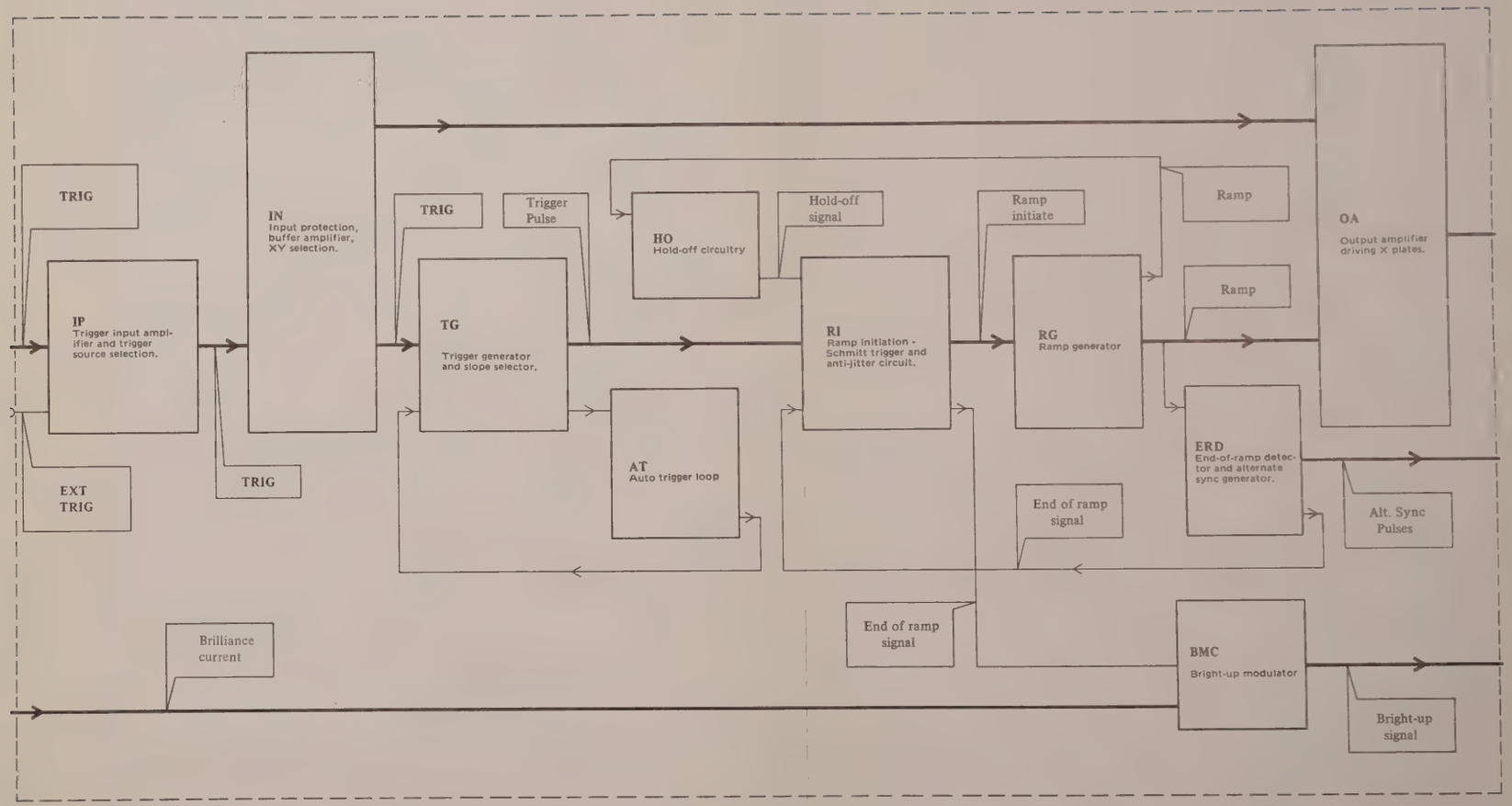


Fig. 10.1 A111 Block Diagram

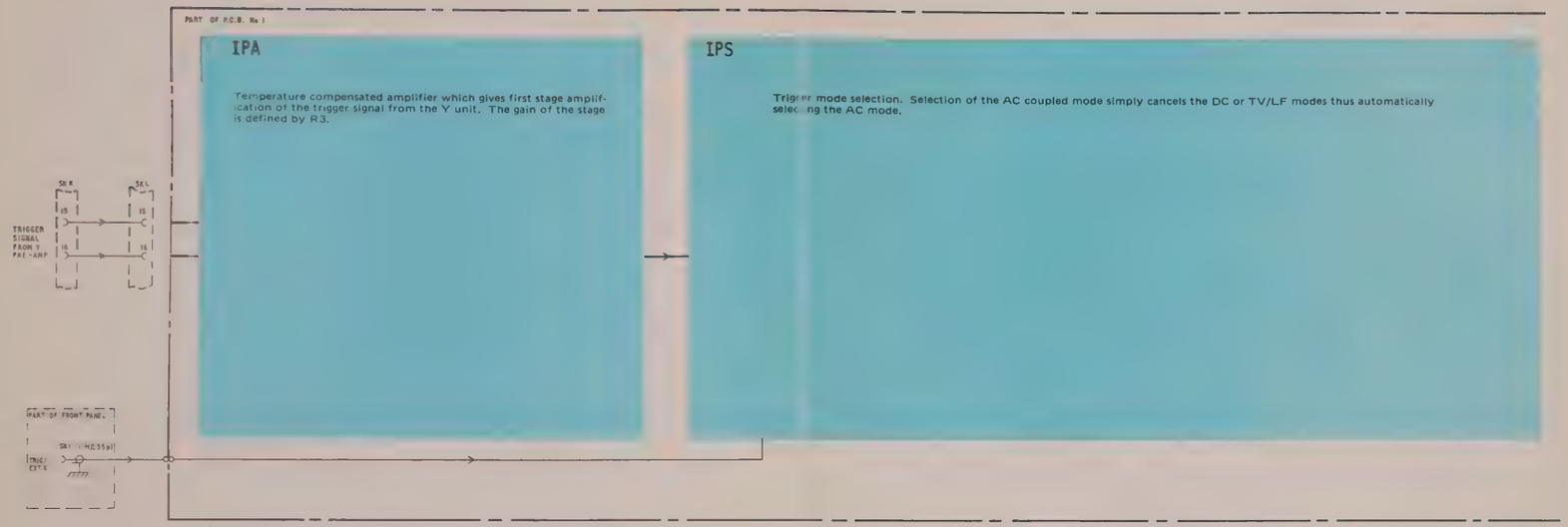

PART OF P.C.B. No 1
IPA
Temperature compensated amplifier which gives first stage amplification of the trigger signal from the Y unit. The gain of the stage is defined by R3.
IPS
Trigger mode selection. Selection of the AC coupled mode simply cancels the DC or TV/LF modes thus automatically selecting the AC mode.
SK K
SK L
15
16
TRIGGER SIGNAL FROM Y PRE-AMP
PART OF FRONT PANEL
TRIG/ EXT X

Fig. 10.2 Input Amplifier and Switching Block Diagram

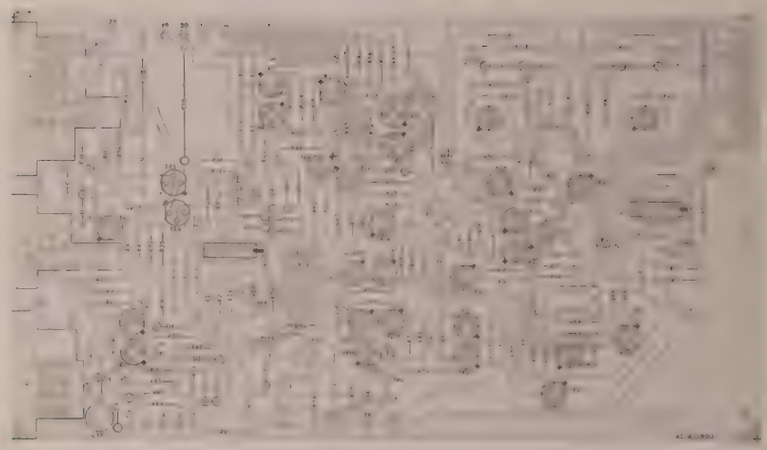


Fig. 10.3 PCB no.1 (Component Side)

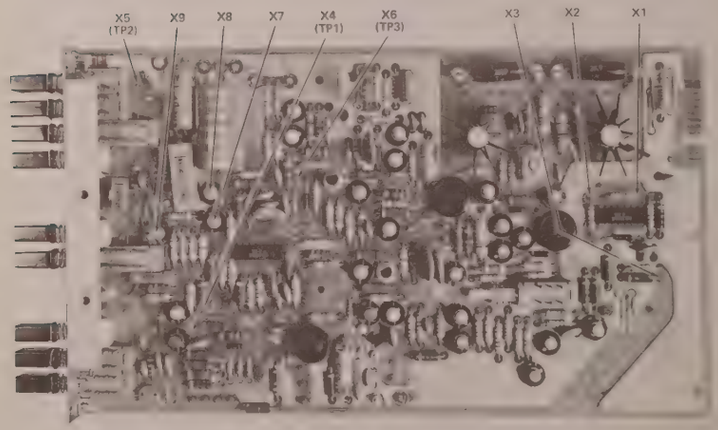
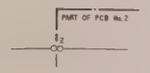


Fig. 10.4 PCB no.1 (Front Panel Assembly Removed)



Disconnect pin no. 2 of pcb no. 2

Edge connector no. 5 of pcb no. 2

Test information point

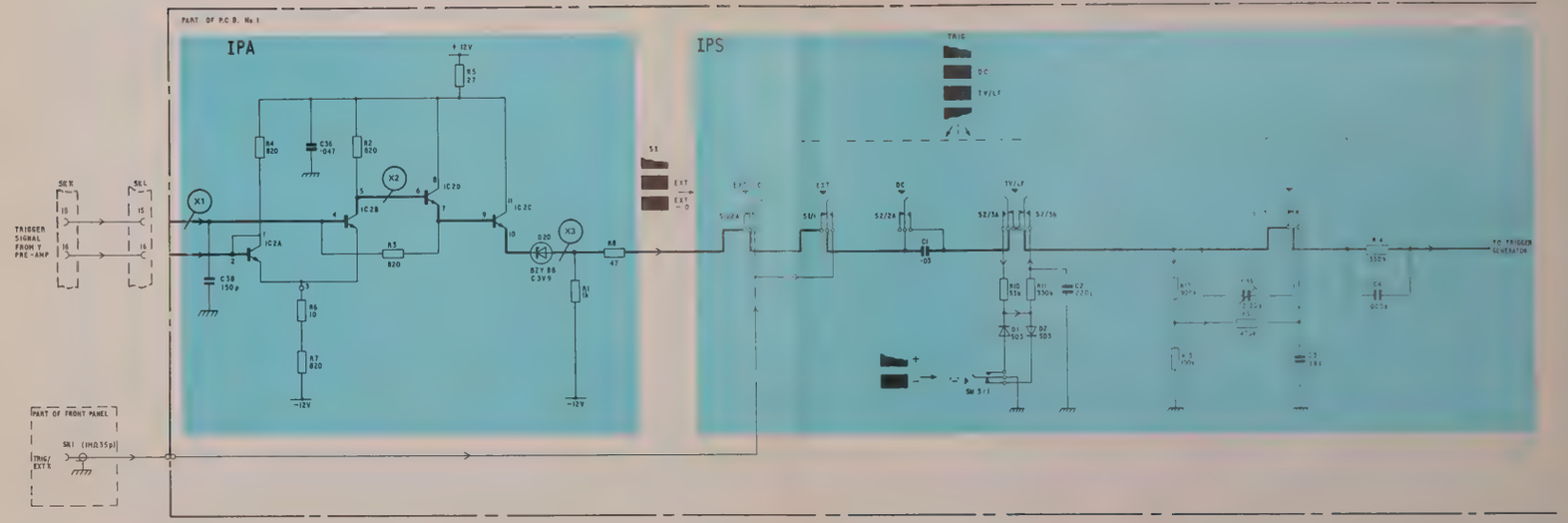


Fig. 10.5 Input Amplifier and Switching (DA1117001)

Table 10.2 Test Information Points X1 to X3 - Input Amplifier

Point	DC Level	Voltage Peak-to-Peak	Remarks
X1	-0.47V	25mV	A DC level of between +0.7V and -0.7V is normal.
X2	+4.9V	3.1V	
X3	-0.5V	3V	A DC level of between +0.7V and -0.7V is normal.

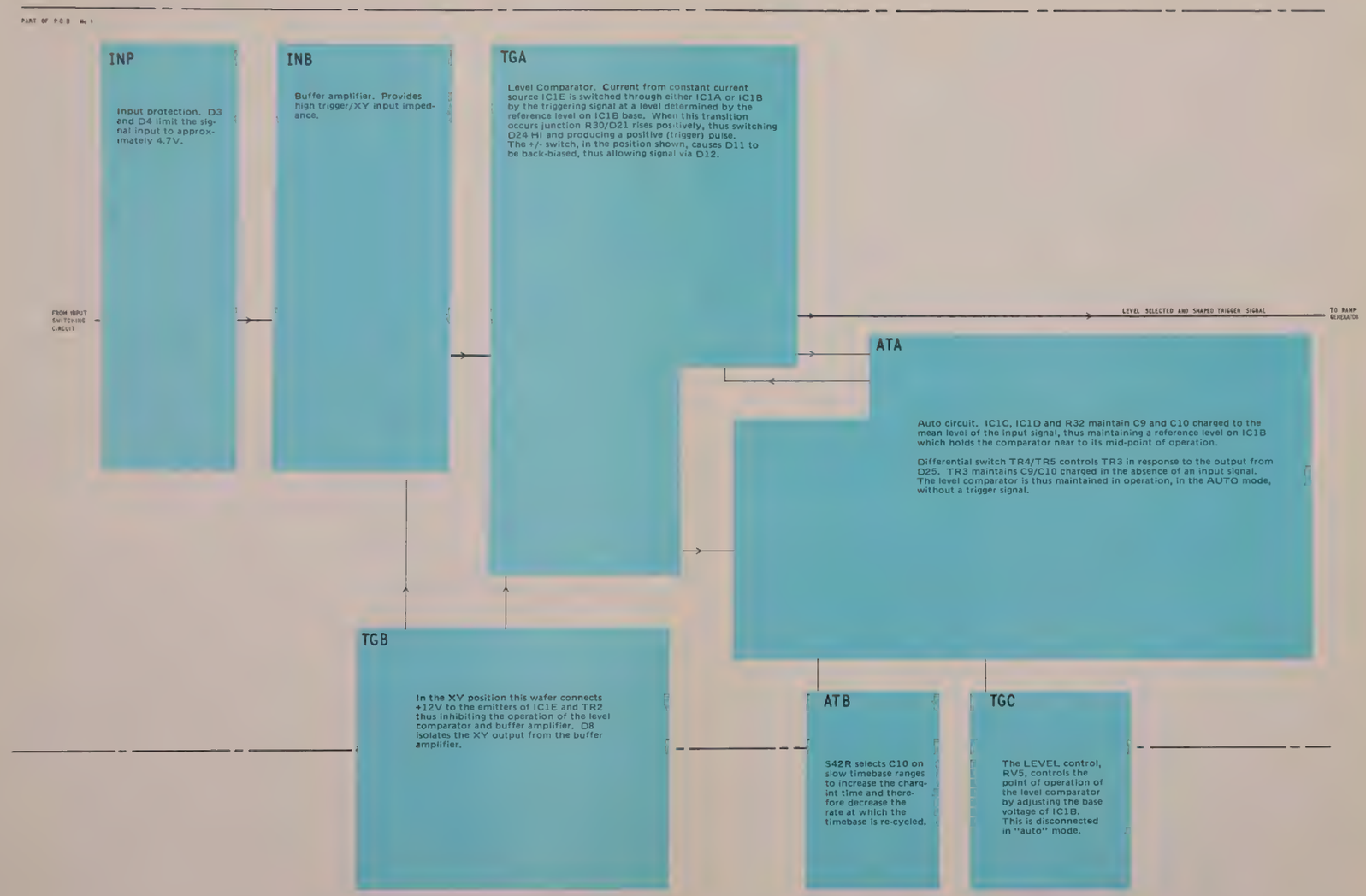

PART OF P.C.B No 1
INP
Input protection. D3 and D4 limit the signal input to approximately 4.7V.
INB
Buffer amplifier. Provides high trigger/XY input impedance.
TGA
Level Comparator. Current from constant current source IC1E is switched through either IC1A or IC1B by the triggering signal at a level determined by the reference level on IC1B base. When this transition occurs junction R30/D21 rises positively, thus switching D24 HI and producing a positive (trigger) pulse.
The +/- switch, in the position shown, causes D11 to be back-biased, thus allowing signal via D12.
FROM INPUT SWITCHING CIRCUIT
LEVEL SELECTED AND SHAPED TRIGGER SIGNAL
TO RAMP GENERATOR
ATA
Auto circuit. IC1C, IC1D and R32 maintain C9 and C10 charged to the mean level of the input signal, thus maintaining a reference level on IC1B which holds the comparator near to its mid-point of operation.
Differential switch TR4/TR5 controls TR3 in response to the output from D25. TR3 maintains C9/C10 charged in the absence of an input signal. The level comparator is thus maintained in operation, in the AUTO mode, without a trigger signal.
TGB
In the XY position this wafer connects +12V to the emitters of IC1E and TR2 thus inhibiting the operation of the level comparator and buffer amplifier. D8 isolates the XY output from the buffer amplifier.
ATB
S42R selects C10 on slow timebase ranges to increase the charg-int time and therefore decrease the rate at which the timebase is re-cycled.
TGC
The LEVEL control, RV5, controls the point of operation of the level comparator by adjusting the base voltage of IC1B. This is disconnected in "auto" mode.

Fig. 10.6 Trigger Generator Block Diagram

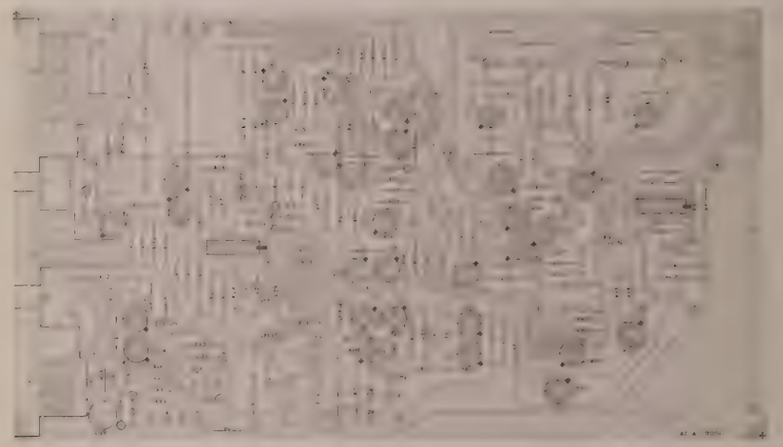


Fig. 10.7 PCB no.1 (Component Side)

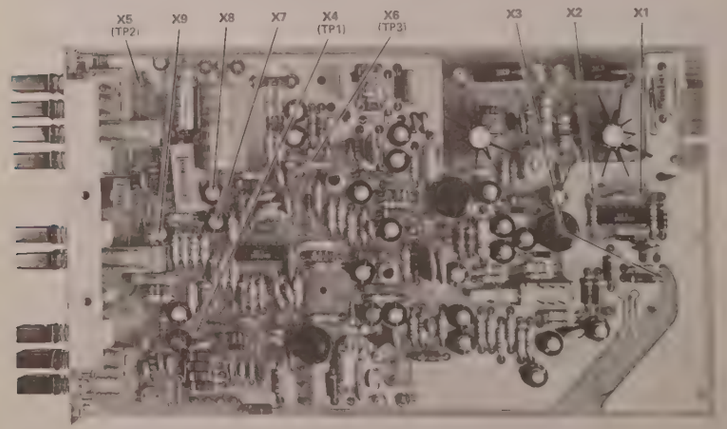


Fig. 10.8 PCB no.1 (Front Panel Assembly Removed)

Circuit Notes

Disconnect pin no. 2 of pcb no. 2

Edge connector no. 5 of pcb no. 2

Test information point

Table 10.3 Test Information Points X4 to X9 - Trigger Generator

Point	Measurement at Standard Settings	Remarks
X4 (TP1)	+ 2·5V − 0·4V	
X5 (TP2)	+ 25mV + 21mV	When 'auto' is selected, waveform changes to that of X9.
X6 (TP3)	+ 0·5V 0V	
X7	+ 12·5V + 2·5V	
X8	+ 4·5 + 2·2	
X9	+ 0·62 + 0·58	

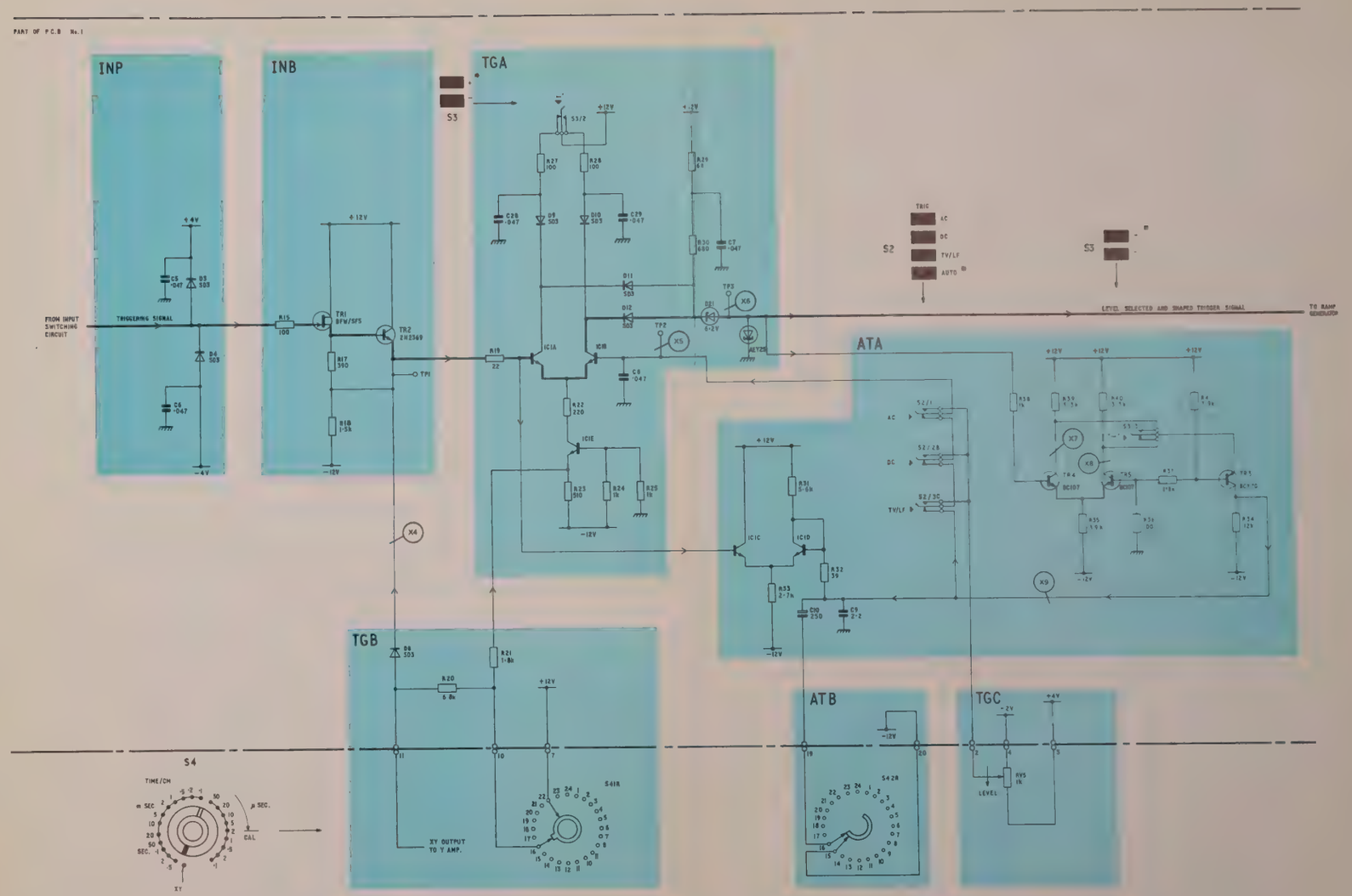


Fig. 10.9 Trigger Generator (DA1117002)

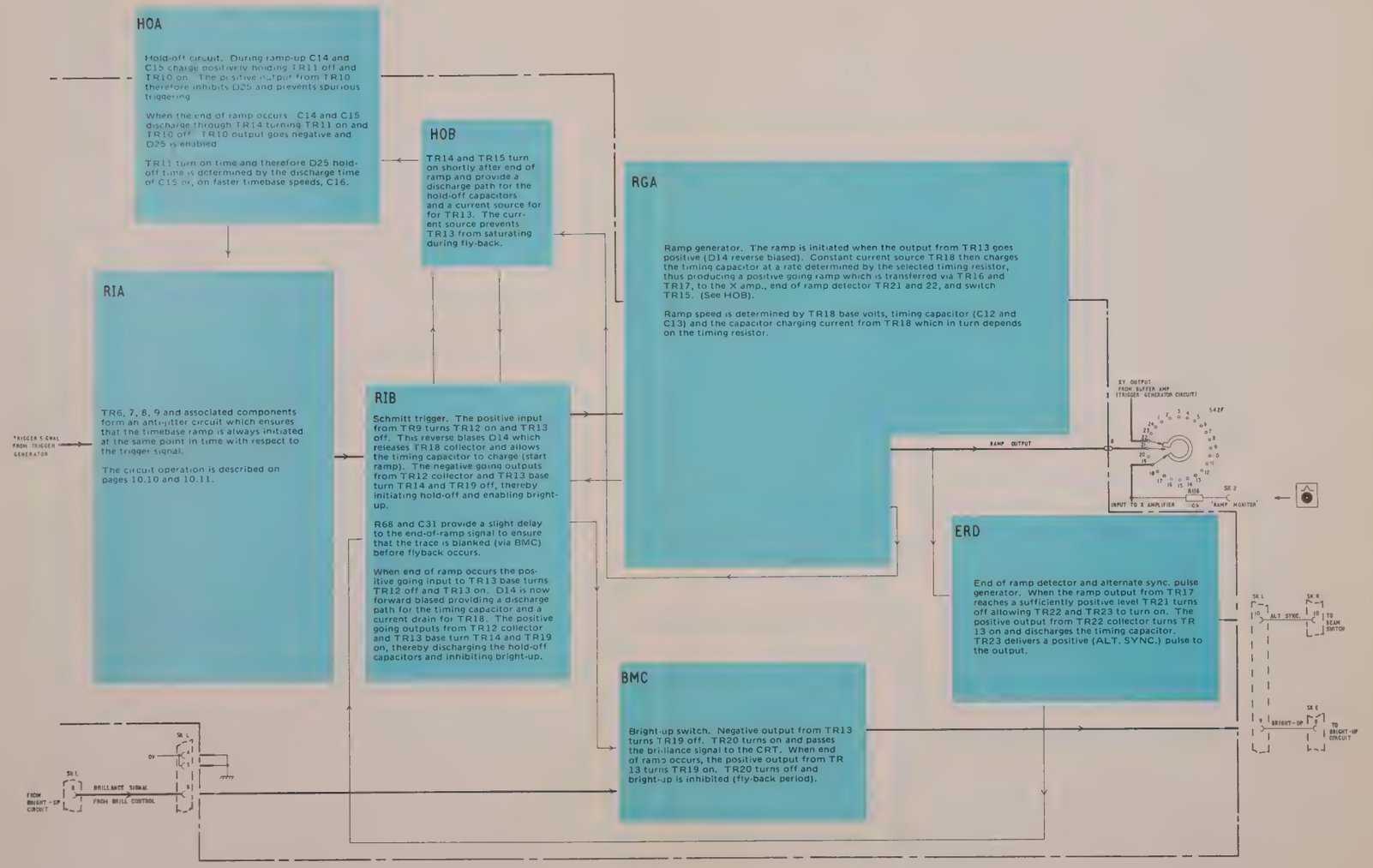

HOA
Hold-off circuit. During ramp-up C14 and C15 charge positively holding TR11 off and TR10 on. The positive output from TR10 therefore inhibits D25 and prevents spurious triggering.
When the end of ramp occurs C14 and C15 discharge through TR14 turning TR11 on and TR10 off. TR10 output goes negative and D25 is enabled.
TR11 turn on time and therefore D25 hold-off time is determined by the discharge time of C15 or, on faster timebase speeds, C16.
HOB
TR14 and TR15 turn on shortly after end of ramp and provide a discharge path for the hold-off capacitors and a current source for for TR13. The current source prevents TR13 from saturating during fly-back.
RGA
Ramp generator. The ramp is initiated when the output from TR13 goes positive (D14 reverse biased). Constant current source TR18 then charges the timing capacitor at a rate determined by the selected timing resistor, thus producing a positive going ramp which is transferred via TR16 and TR17, to the X amp., end of ramp detector TR21 and 22, and switch TR15. (See HOB).
Ramp speed is determined by TR18 base volts, timing capacitor (C12 and C13) and the capacitor charging current from TR18 which in turn depends on the timing resistor.
RIA
TR6, 7, 8, 9 and associated components form an anti-jitter circuit which ensures that the timebase ramp is always initiated at the same point in time with respect to the trigger signal.
The circuit operation is described on pages 10.10 and 10.11.
RIB
Schmitt trigger. The positive input from TR9 turns TR12 on and TR13 off. This reverse biases D14 which releases TR18 collector and allows the timing capacitor to charge (start ramp). The negative going outputs from TR12 collector and TR13 base turn TR14 and TR19 off, thereby initiating hold-off and enabling bright-up.
R68 and C31 provide a slight delay to the end-of-ramp signal to ensure that the trace is blanked (via BMC) before flyback occurs.
When end of ramp occurs the positive going input to TR13 base turns TR12 off and TR13 on. D14 is now forward biased providing a discharge path for the timing capacitor and a current drain for TR18. The positive going outputs from TR12 collector and TR13 base turn TR14 and TR19 on, thereby discharging the hold-off capacitors and inhibiting bright-up.
ERD
End of ramp detector and alternate sync. pulse generator. When the ramp output from TR17 reaches a sufficiently positive level TR21 turns off allowing TR22 and TR23 to turn on. The positive output from TR22 collector turns TR 13 on and discharges the timing capacitor. TR23 delivers a positive (ALT. SYNC.) pulse to the output.
BMC
Bright-up switch. Negative output from TR13 turns TR19 off. TR20 turns on and passes the brilliance signal to the CRT. When end of ramp occurs, the positive output from TR 13 turns TR19 on. TR20 turns off and bright-up is inhibited (fly-back period).
TRIGGER SIGNAL FROM TRIGGER GENERATOR
RAMP OUTPUT
XY OUTPUT FROM BUFFER AMP (TRIGGER GENERATOR CIRCUIT)
INPUT TO X AMPLIFIER
'RAMP' MONITOR
ALT SYNC
TO BEAM SWITCH
BRIGHT-UP
TO BRIGHT-UP CIRCUIT
FROM BRIGHT-UP CIRCUIT
BRILLIANCE SIGNAL FROM BRILL CONTROL
0V

Fig. 10.10 Ramp Generator Block Diagram

Procedure 111 Cal 3

Ramp rate.

1. Set TIME/CM switch to 1ms, and fine velocity to CAL.
2. Display 1kHz time markers from Bradley 192 or 156.
3. Adjust RV2 to obtain maximum accuracy over the centre 8cm.

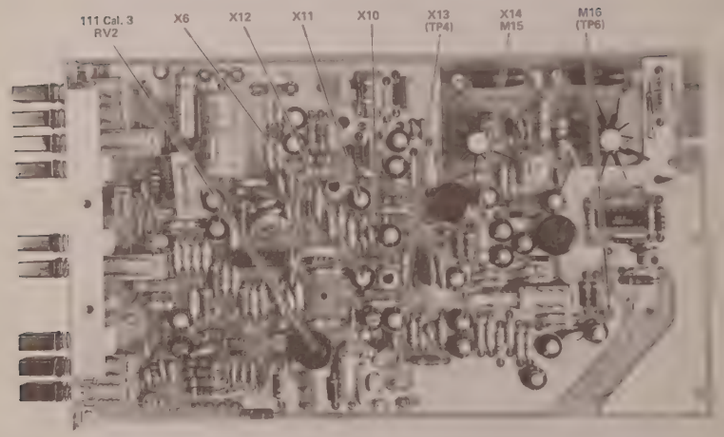


Fig. 10.11 PCB no. 1 (Front Panel Assembly Removed)

Table 10.4 Test Information Points X10 to X14 - Ramp Generator

Point	Measurement at Standard Settings	Remarks
X6	+ 0·5V 0V	
X10	− 3·7V − 5V	
X11	− 1V − 3·5V − 4V	
X12	+ 4 − 1 − 2·4	

Table 10.4 (Continued)

Point	Measurement at Standard Settings	Remarks
X13 (TP4)	+ 4V - 1·2V	
X14 (M15)	- 4·5 V - 6V	See Fig. 8.15
M16	+550mV +300mV	

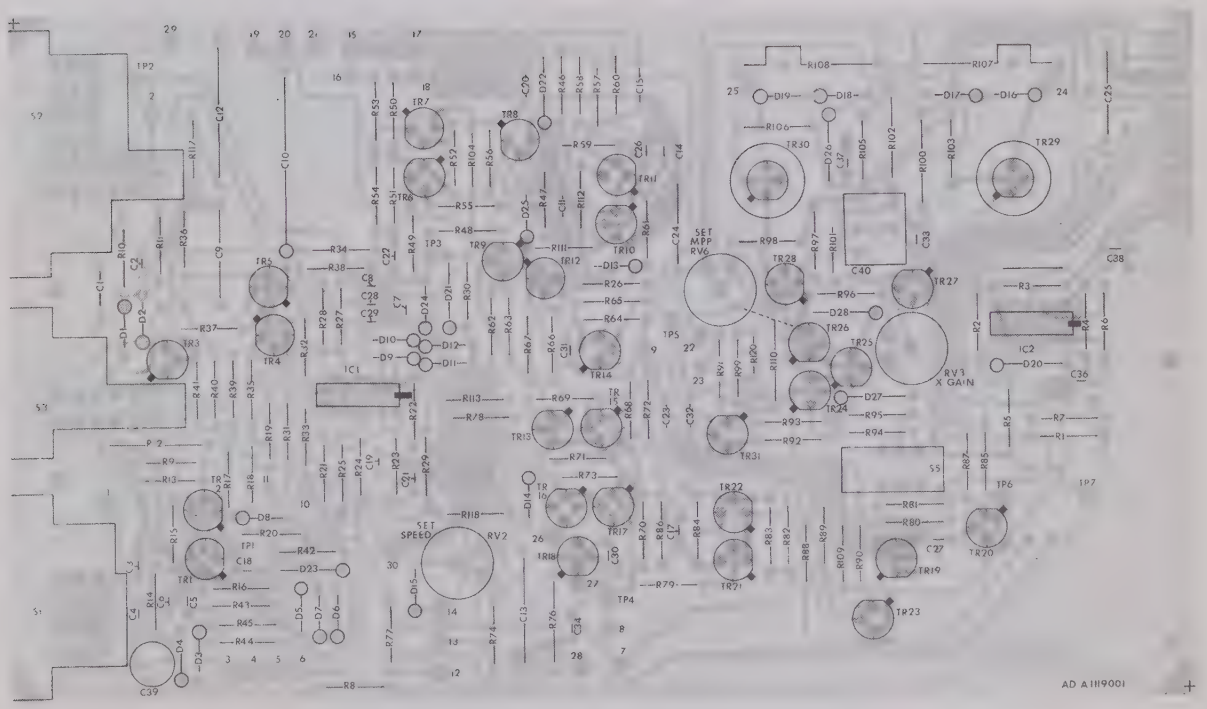


Fig. 10.12 PCB no. 1 (Component Side)

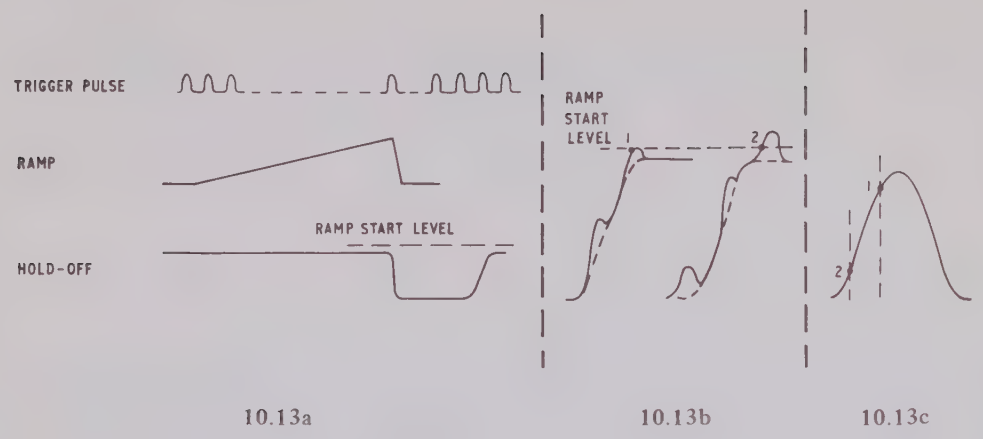


Fig. 10.13

Introduction

Most modern designs of timebase incorporate a hold-off system to allow the circuitry to reach its quiescent state between end of ramp and the next trigger pulse. However, as neither the trigger pulse low-high transition nor the hold-off transition occur instantaneously, there is a condition where jitter may occur. This condition is outlined in Fig. 10.13, and is most noticeable at high countdown rates.

Consider the conditions at the end of hold-off. The hold-off level rises, ready for the next trigger pulse to initiate the ramp. Ramp start will occur when the trigger pulse, superimposed on the hold-off level, reaches the switching level of the ramp initiation bistable. Two possible conditions are illustrated in Fig. 10.13b; these are equivalent to the ramp triggering at point 1 or point 2 on Fig. 10.13c.

One method of minimising this effect, which is observed as a normal trace accompanied by a ghost trace displaced horizontally, is to ensure that the hold-off and trigger pulse rise-times are very short; for fast timebase speeds, this could be very expensive. A simpler method is to ensure that, if a trigger pulse coincides with the end of hold-off, it does not trigger the timebase. This is the principle of the A100 anti-jitter circuit.

During hold-off time, TR10 draws 5.7mA from TR7 collector. As TR7 can only supply a maximum of 5.9mA, there is insufficient current through D25 to allow it to remain in the high current state. TR10 is cut off outside hold-off time, so that once D25 is made to conduct, it remains in conduction until the hold-off signal re-appears.

Case 1 Hold-Off terminates before Trigger Pulse arrives

The trigger pulse causes TR6 to conduct, and the step applied to the open circuit delay line keeps TR6 in conduction for 12ns. Similarly, TR7 conducts for 5ns. When TR6 conducts, it 'robs' all tail current from the long-tail pair TR8 and TR9. Therefore, TR9 cannot conduct to start the ramp until 12ns after the trigger pulse leading edge. As hold-off has already ended, D25 will be switched from its low-current state to its high current state by the 5ns pulse from TR7. It will remain in that state after the end of the 5ns pulse due to its bistable action, placing TR9 base more negative than TR8 base. At the end of the 12ns period, when tail current is restored, TR9 will conduct, initiating the ramp. D25 will reset to its low state when the next hold-off period starts.

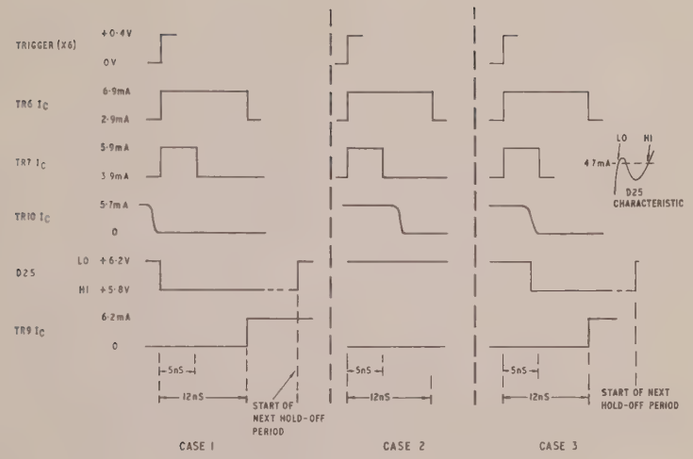


Fig. 10.14 Block RIA Waveforms

Case 2 Hold-Off terminates after 5ns delay

As before, the trigger pulse causes TR6 to conduct for 12ns, ensuring TR9 is cut off, and TR7 conducts for 5ns. In this case, the hold-off is still operative, so that D25 cannot switch. After 5ns, TR7 cuts off; TR9 base will remain less negative than TR8 base, so TR9 remains cut off. Thus the trigger pulse is lost, which is the intention of the hold-off circuit.

Case 3 Hold-Off terminates during the 5ns delay time

This is the critical case, where jitter could occur if measures were not taken to prevent it. The trigger pulse again inhibits TR9 for 12ns. If termination of hold-off occurs at any time during the 5ns conduction period of TR7, D25 will switch, and conditions at case 1 apply. If end of hold-off and the end of the 5ns pulse coincide, D25 may or may not switch, depending on the exact time relationship between the two events. However, the only result of this indecision is that the ramp may or may not start at the end of the 12ns fixed delay period. Jitter is thus eliminated.

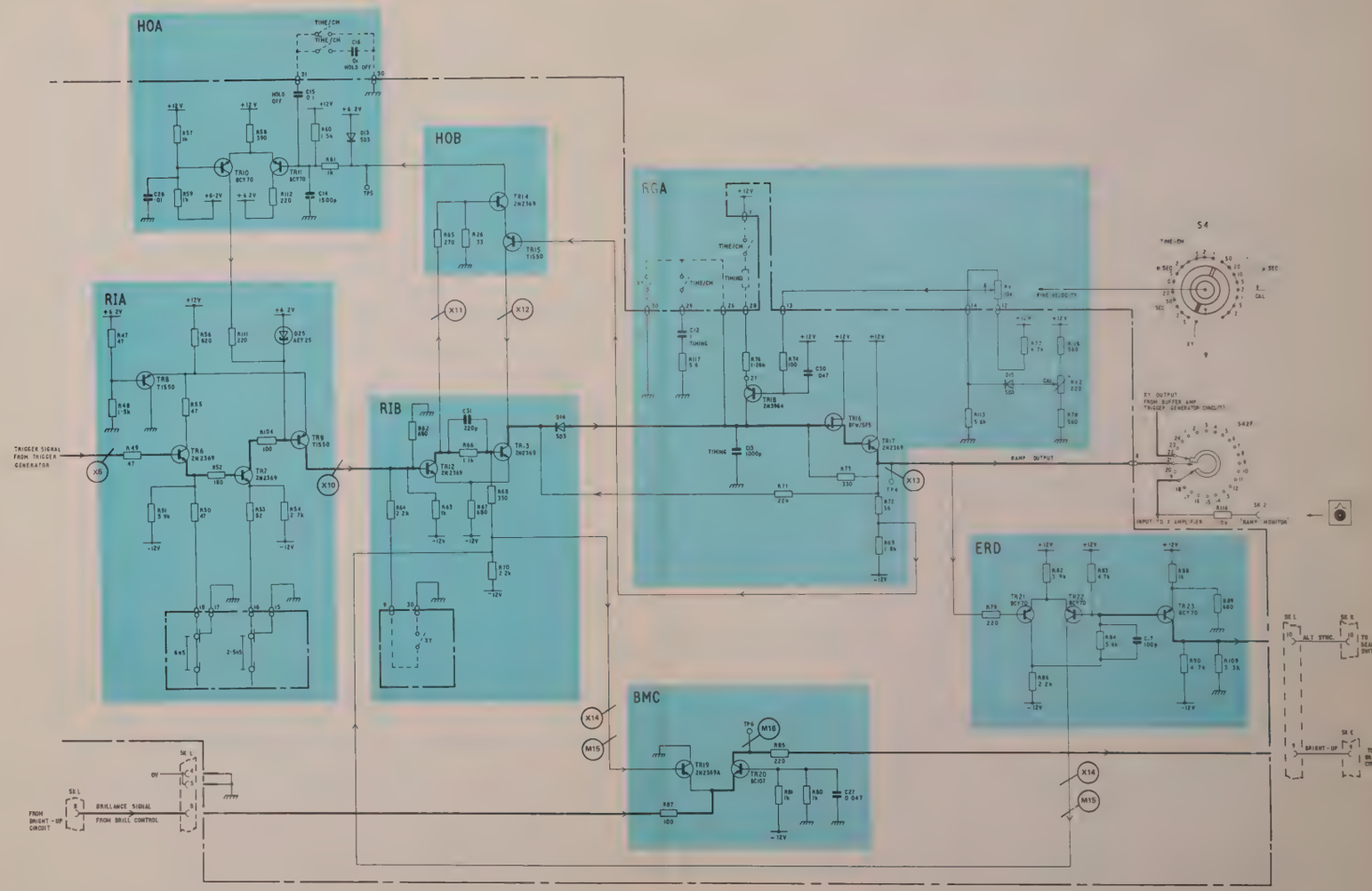


Fig. 10.15 Ramp Generator (DA1117003)

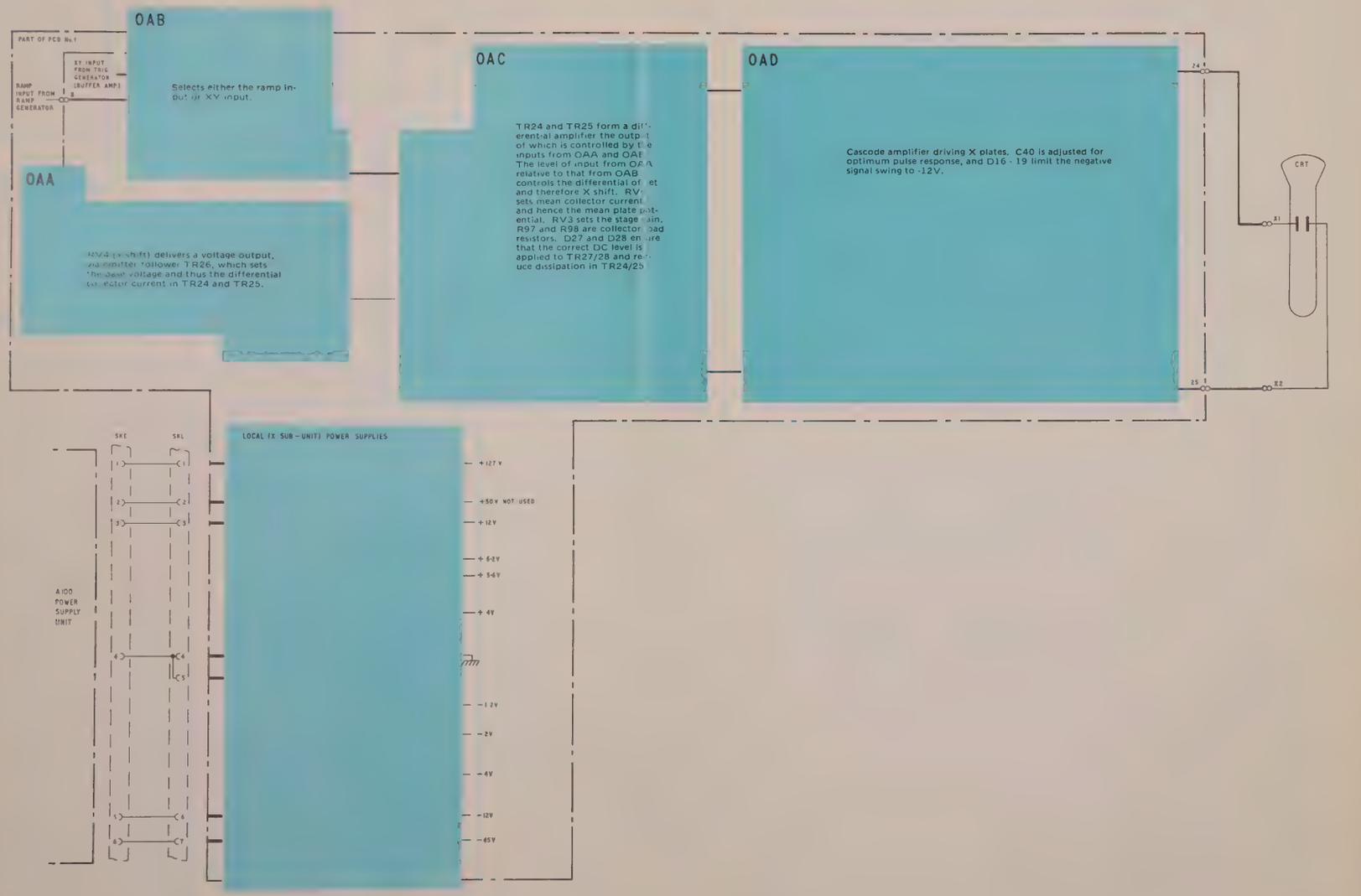

OAB
PART OF PCB No.1
XY INPUT FROM TRIG GENERATOR (BUFFER AMP)
RAMP INPUT FROM RAMP GENERATOR
Selects either the ramp input or XY input.
OAA
RV4 (X shift) delivers a voltage output, via emitter follower TR26, which sets the base voltage and thus the differential collector current in TR24 and TR25.
OAC
TR24 and TR25 form a differential amplifier the output of which is controlled by the inputs from OAA and OAB. The level of input from OAA relative to that from OAB controls the differential output and therefore X shift. RV5 sets mean collector current and hence the mean plate potential. RV3 sets the stage gain. R97 and R98 are collector load resistors. D27 and D28 ensure that the correct DC level is applied to TR27/28 and reduce dissipation in TR24/25
OAD
Cascode amplifier driving X plates. C40 is adjusted for optimum pulse response, and D16 - 19 limit the negative signal swing to -12V.
24
25
CRT
X1
X2
SKE
SKL
A100 POWER SUPPLY UNIT
LOCAL (X SUB-UNIT) POWER SUPPLIES
+127 V
+50V NOT USED
+12 V
+6·2V
+5·4V
+4V
-12V
-2V
-4V
-12V
-65V

Fig. 10.16 Output Amplifier and Local Supplies Block Diagram

Procedure 111 Cal 1

Mean plate potential.

1. Connect AVO between X plates. Select XY and adjust X shift control for zero volts reading.
2. Transfer negative AVO lead to chassis. Adjust RV6 to obtain a reading of 40V ± 1V.

Procedure 111 Cal 2

Horizontal gain and LF pulse response.

1. Select XY on TIME/CM switch, DC trigger coupling, and EXT on trigger selector.
2. Connect 1kHz output of Bradley 192 or 156 at 4V amplitude to EXT X input. Two horizontally opposed spots will appear.
3. Adjust RV3 and X shift control to place the spots behind the 2nd and 10th graticule lines.
4. Switch trigger selector to EXT ÷10. Increase square wave signal to 40V amplitude.
5. Adjust C39 to remove any feathering around the spots.

Procedure 111 Cal 4

HF pulse response and sweep speed check.

1. Set TIME/CM switch to 0.1μs/cm, with X5 expansion.
2. Apply 50MHz signal from Bradley 192 or 156 to Y input.
3. Adjust C40 to obtain maximum accuracy over the centre 8cm.
4. Return expansion switch to X1. Check all sweep speeds for specified accuracy using time markers from Bradley 192 or 156. If necessary, readjust RV2 to bring all speeds within specification.

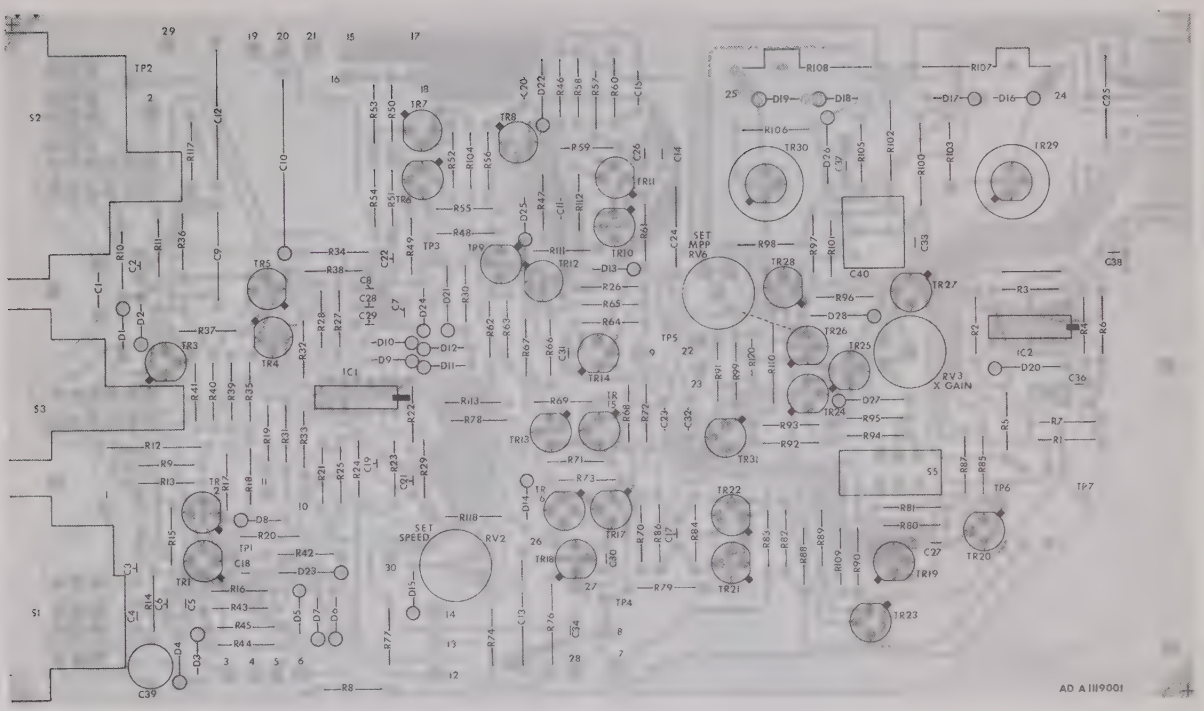


Fig. 10.17 PCB no. 1 (Component Side)

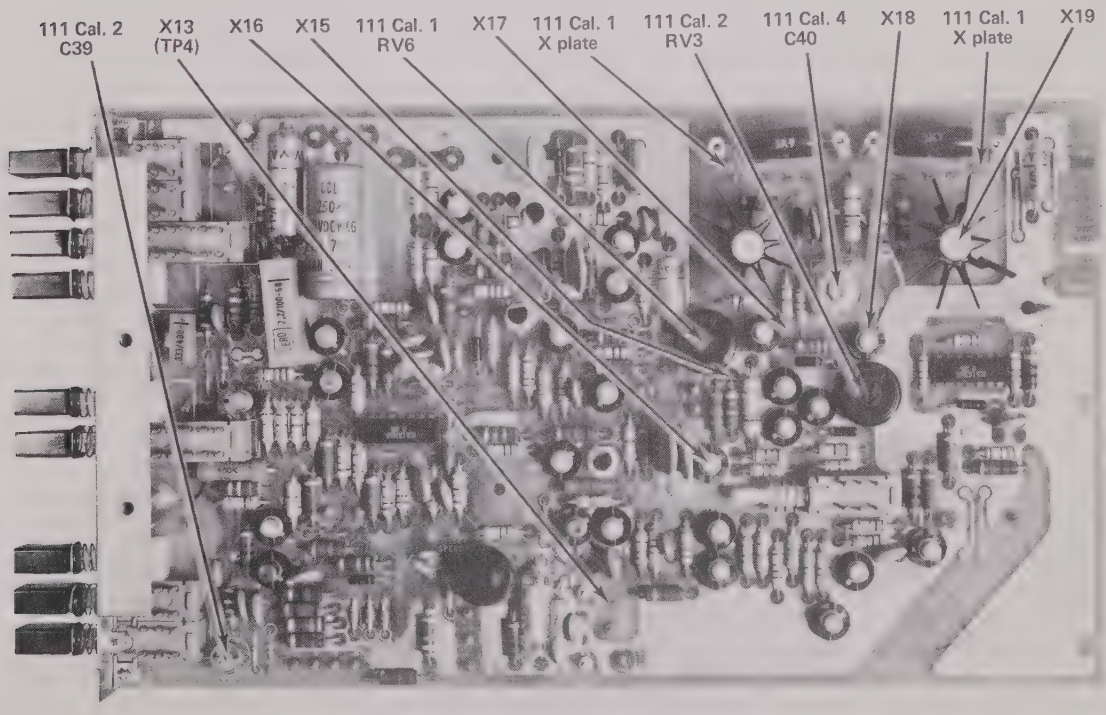


Fig. 10.18 PCB no. 1 (Front Panel Assembly Removed)

Table 10.5 Test Information Points X14 to X19 - Output Amplifier

Point	Measurement at Standard Settings	Remarks
X14		
X15	+0.93V	
X16	+4.45V	
X17		
X18		
X19		

Circuit Notes

Disconnect pin no. 2 of pcb no. 2

Edge connector no. 5 of pcb no. 2

Test information point

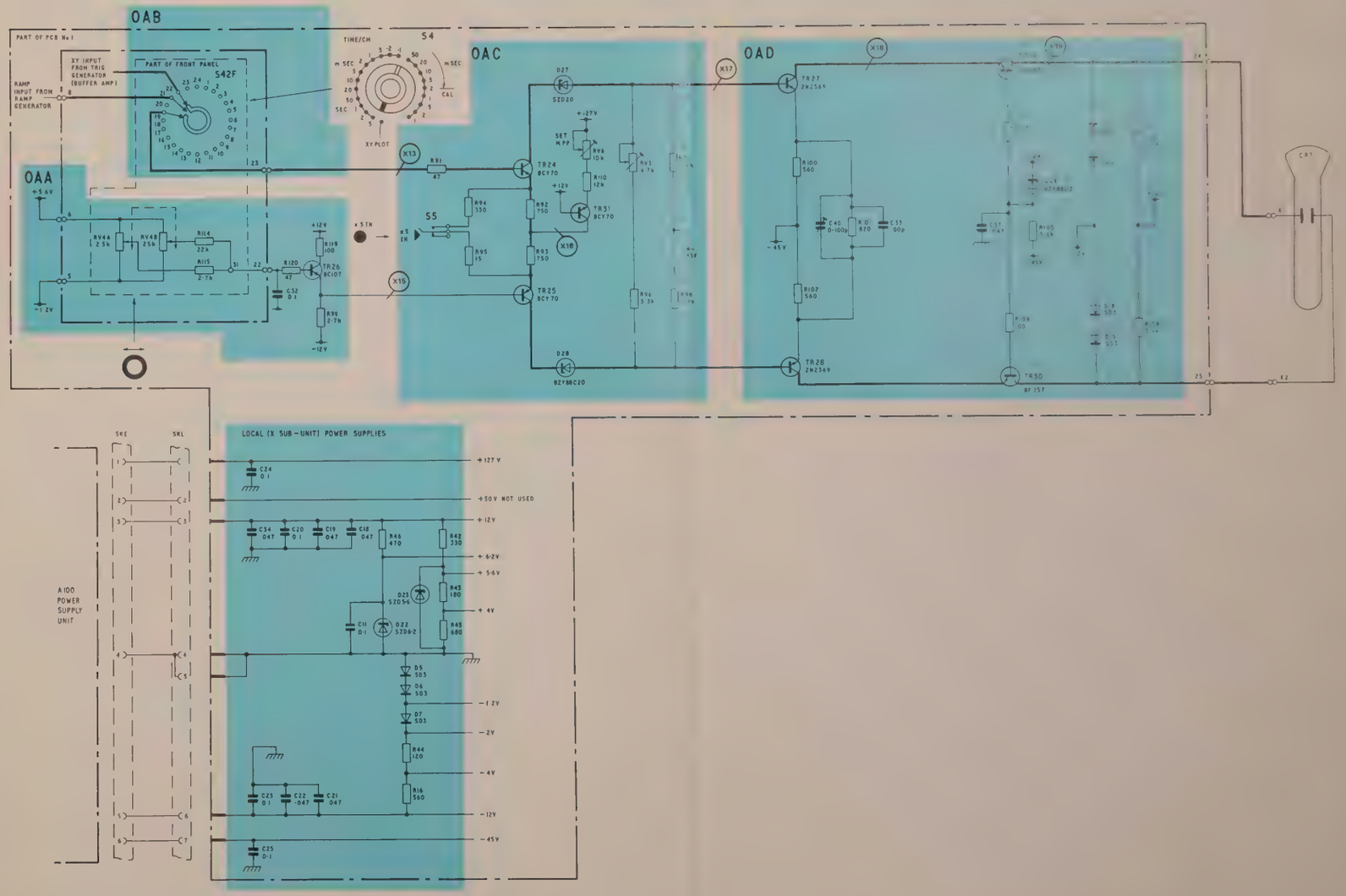


Fig. 10.19 Output Amplifier and Local Supplies (DA1117004)

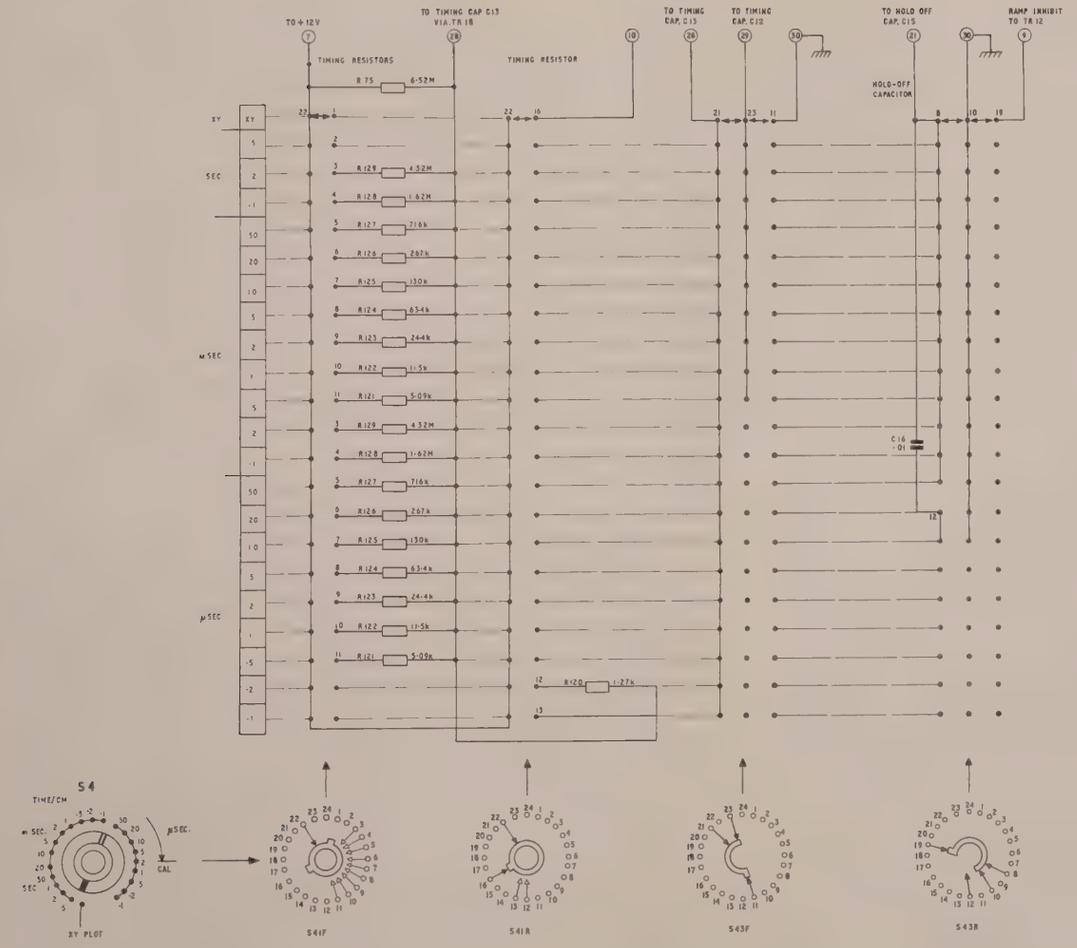


Fig. 10.20 Time/Cm Switch (DA1117005)

COMPONENT PARTS LIST ABBREVIATIONS

Circuit References

B	Battery
C	Capacitor (µF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

Component Composition

FIXED RESISTORS

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Component Composition (Cont'd)

VARIABLE RESISTORS

Wirewound Preset Single Turn	WWPS
Wirewound Preset Multiturn	WWPM
Wirewound Front Panel Single Turn	WWFS
Wirewound Front Panel Multiturn	WWFM
Carbon Preset Single Turn	CAPS
Carbon Preset Multiturn	CAPM
Carbon Front Panel Single Turn	CAFS
Carbon Front Panel Multiturn	CAFM
Cermet Preset Single Turn	CMPS
Cermet Preset Multiturn	CMPM
Cermet Front Panel Single Turn	CMFS
Cermet Front Panel Multiturn	CMFM

CAPACITORS

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Column 4 indicates rating (Watts or Volts)
Column 5 indicates tolerance (%)

Component Parts List for General Assembly

Cct. Ref.	General Description					Solartron Part No.
R114	CACP	22k	⅛	10		172342200
R115	CACP	2.7k	⅛	10		172332700
RV1	CAFS	10k	½	20		119600501
(RV4A/	CAFS	2.5k	½	20		119600601
(RV4B	CAFS	25k	½	20		
RV5	CAFS	1k	½	20		110010054
SKA	BNC Panel Socket					352101300
SKB	2m Panel Socket					352501590
SW1	Push Button Switch					379601201
SW2	Push Button Switch					379601301
SW3	Push Button Switch					379601101

Component Parts List for Timebase Switch Assembly

Cct. Ref.	General Description					Solartron Part No.
R75	MEFM	6.52	1	.5		160400489
R116	CACP	10k	⅛	10		172341000
R120	MEFM	1.27k	⅛	.5		198331271
R121	MEFM	5.09k	⅛	.5		198235091
R123	MEFM	24.4k	⅛	.5		198242441
R124	MEFM	63.4k	⅛	.5		198246341
R125	MEFM	130k	⅛	.5		198251301
R122	MEFM	11.5k	⅛	.5		198241151
R123	MEFM	24.4k	⅛	.5		198242441
R124	MEFM	63.4k	⅛	.5		198246341
R125	MEFM	130k	⅛	.5		198251301
R126	MEFM	267k	⅛	.5		198252671
R127	MEFM	716k	½	.5		198557161
R128	MEFM	1.62M	½	.5		198561621
R129	MEFM	4.32M	½	.5		160400470
C16	CERM	.01p	25	+50 -20		241941000

Component Parts List

for

PCB No.1 (A1119001)

Cct. Ref.	General Description				Solartron Part No.
R1	CACP	1k	¼	10	172331000
R2	MEOX	820	½	1	195428200
R3	MEOX	820	½	1	195428200
R4	MEOX	820	½	1	195428200
R5	CACP	27	¼	10	172312700
R6	CACP	10	¼	10	172311000
R7	MEOX	820	½	1	195428200
R8	CACP	47	¼	10	172314700
R9	CACP	470k	¼	10	172354700
R10	CACP	33k	¼	10	172343300
R11	CACP	330k	¼	10	172353300
R12	MEFM	900k	½	1	198659003
R13	MEOX	100k	½	1	195451000
R14	CACP	330k	¼	10	172353300
R15	CACP	100	¼	10	172321000
R16	CACP	560	¼	10	172325600
R17	MEOX	390	½	5	193523900
R18	CACP	1.5k	¼	10	172331500
R19	CACP	22	¼	10	172312200
R20	CACP	6.8k	¼	10	172336800
R21	CACP	1.8k	¼	10	172331800
R22	CACP	220	¼	10	172322200
R23	MEOX	510	½	1	195425100
R24	MEOX	1k	½	1	195431000
R25	MEOX	1k	½	1	195431000
R26	CACP	33	¼	10	172313300
R27	CACP	100	¼	10	172321000
R28	CACP	100	¼	10	172321000
R29	MEOX	68	½	5	193516800
R30	MEOX	680	½	1	195426800
R31	MEOX	5.6k	½	1	195435600
R32	MEOX	39	½	1	195413900
R33	MEOX	2.7k	½	1	195432700
R34	MEOX	12k	½	1	195441200
R35	MEOX	3.9k	½	5	193533900
R36	MEOX	100	½	5	193521000
R37	MEOX	1.8k	½	1	195431800
R38	CACP	1k	¼	10	172331000
R39	MEOX	3.3k	½	1	195433300
R40	MEOX	3.3k	½	1	195433300
R41	MEOX	3.9k	½	1	195433900
R42	CACP	330	¼	10	172323300
R43	CACP	180	¼	10	172321800
R44	CACP	120	¼	10	172321200
R45	CACP	680	¼	10	172326800
R46	CACP	470	¼	10	172324700
R47	MEOX	47	½	5	193514700
R48	MEOX	1.5k	½	1	195431500
R49	CACP	47	¼	10	172314700
R50	MEOX	47	½	1	195414700
R51	MEOX	3.9k	½	1	195433900
R52	CACP	180	¼	10	172321800
R53	MEOX	82	½	1	195418200
R54	MEOX	2.7k	½	1	195432700
R55	CACP	47	¼	10	172314700
R56	MEOX	820	½	1	195428200
R57	MEOX	1k	½	1	195431000
R58	MEOX	390	½	1	195423900
R59	MEOX	1k	½	1	195431000
R60	MEOX	1.5k	½	1	195431500
R61	MEOX	1k	½	1	195431000
R62	MEOX	680	½	1	195426800
R63	MEOX	1k	½	1	195431000
R64	CACP	2.2k	¼	10	172332200

Cct Ref.	General Description				Solartron Part No.
R65	MEOX	270	½	1	195422700
R66	MEOX	1.1k	½	1	195431100
R67	MEOX	680	½	1	195426800
R68	MEOX	330	½	5	193523300
R69	CACP	1.8k	¼	10	172331800
R70	MEOX	2.2k	½	1	195432200
R71	CACP	22k	¼	10	172342200
R72	CACP	56	¼	10	172315600
R73	MEOX	330	½	5	193523300
R74	CACP	100	¼	10	172321000
R76	MEFM	1.26k	¼	.5	198231261
R77	CACP	4.7k	¼	10	172334700
R78	MEOX	560	½	5	193525600
R79	CACP	220	¼	10	172322200
R80	MEOX	1k	½	1	195431000
R81	MEOX	1k	½	1	195431000
R82	MEOX	3.9k	½	1	195433900
R83	MEOX	4.7k	½	1	195434700
R84	MEOX	5.6k	½	1	195435600
R85	CACP	220	¼	10	172322200
R86	MEOX	2.2k	½	1	195432200
R87	CACP	100	¼	10	172321000
R88	MEOX	1k	½	1	195431000
R89	MEOX	680	½	1	195426800
R90	MEOX	4.7k	½	5	193534700
R91	CACP	47	¼	10	172314700
R92	MEOX	750	½	1	195427500
R93	MEOX	750	½	1	195427500
R94	MEOX	330	½	1	195423300
R95	MEOX	15	½	5	193511500
R96	CACP	3.3k	¼	10	172333300
R97	MEOX	3.9k	½	1	195433900
R98	MEOX	3,9k	½	1	195433900
R99	CACP	2.7k	¼	10	172332700
R100	MEOX	560	1	1	197525600
R101	MEOX	820	½	1	195428200
R102	MEOX	560	1	1	197525600
R103	CACP	100	¼	10	172321000
R104	CACP	100	¼	10	172321000
R105	CACP	5.6k	¼	10	172335600
R106	CACP	100	¼	10	172321000
R107	POWW	3.9k	6	1	173633900
R108	POWW	3.9k	6	1	173633900
R109	MEOX	3.3k	½	5	193533300
R110	MEOX	12k	1	5	193441200
R111	CACP	220	¼	10	172322200
R112	CACP	220	¼	10	172322200
R113	CACP	5.6k	¼	10	172335600
R117	CACP	5,6	¼	10	172305600
R118	MEOX	560	½	5	193525600
R119	CACP	100	1/8	10	172021000
R120	CACP	100	1/8	10	172021000
RV2	WWPS	220	1	10	110037230
RV3	CAPS	4.7k	½	20	136634700
RV6	CAPS	10k	½	20	136641000
C1	ESTM	.033	400	10	226043300
C2	CERM	220p	500	20	241322200
C3	CERM	68p	500	20	241316800
C4	CERM	1000p	500	20	241331000
C5	CERM	.047	25	+50 -20	241944700
C6	CERM	.047	25	+50 -20	241944700
C7	CERM	.047	25	+50 -20	241944700
C8	CERM	.047	25	+50 -20	241944700
C9	ESTM	2.2	100	10	225462200
C10	ALME	250	25	+50 -10	270782500
C11	CERM	.1	30	+50 -20	242051000
C12	ESTM	1	160	1	220061000

Cct. Ref.	General Description				Solartron Part No.
C13	STYR	1000p	630	1	210331000
C14	CERM	1500p	500	20	241331500
C15	ESTM	.1	100	10	225451000
C17	CERM	100p	500	20	241321000
C18	CERM	.047	25	+50 -20	241944700
C19	CERM	.047	25	+50 -20	241944700
C20	CERM	.1	30	+50 -20	242051000
C21	CERM	.047	25	+50 -20	241944700
C22	CERM	.047	25	+50 -20	241944700
C23	CERM	.1	30	+50 -20	242051000
C24	ESTM	.1	160	10	220351000
C25	ESTM	.1	160	10	220351000
C26	CERM	.01	25	+50 -20	241941000
C27	CERM	.047	25	+50 -20	241944700
C28	CERM	.047	25	+50 -20	241944700
C29	CERM	.047	25	+50 -20	241944700
C30	CERM	.047	25	+50 -20	241944700
C31	CERM	220p	500	20	241322200
C32	CERM	.1	30	+50 -20	242051000
C33	CERM	100p	500	20	241321000
C34	CERM	.047	25	+50 -20	241944700
C36	CERM	.047	25	+50 -20	241944700
C37	CERM	.047	25	+50 -20	241944700
C38	CERM	150p	500	20	241321500
C39	PYLN	2-22p			290030180
C40	PTFE	4-104p			290030130
D1 to D19	Diode SD3				300522160
D20	BZY88 C3V9				300521440
D21	BZY88 C6V2				300521240
D22	BZY88 C6V2				300521240
D23	BZY88 C5V6				300521450
D24	Tunnel Diode AEY25				300524710
D25	Tunnel Diode AEY25				300524710
D26	BZY88 C12				300521480
D27	BZY88 C20				300523790
D28	BZY88 C20				300523790
TR1	Sil. FET N. Chan. BFW/SF5				300554060
TR2	Trans. Sil. NPN 2N2369A				300552390
TR3	Trans. Sil. PNP BCY70				300553590
TR4	Trans. Sil. NPN BC107S				300553320
TR5	Trans. Sil. NPN BC107S				300553320
TR6	Trans. Sil. NPN 2N2369A				300552390
TR7	Trans. Sil. NPN 2N2369A				300552390
TR8	Trans. Sil. PNP T1S50				300553720
TR9	Trans. Sil. PNP T1S50				300553720
TR10	Trans. Sil. PNP BCY70				300553590
TR11	Trans. Sil. PNP BCY70				300553590
TR12	Trans. Sil. NPN 2N2369A				300552390
TR13	Trans. Sil. NPN 2N2369A				300552390
TR14	Trans. Sil. NPN 2N2369A				300552390
TR15	Trans. Sil. PNP T1S50				300553720
TR16	Sil. FET N. Chan. BFW/SF5				300554060
TR17	Trans. Sil. NPN 2N2369A				300552390
TR18	Trans. Sil. PNP BC214LC				300554150
TR19	Trans. Sil. NPN 2N2369A				300552390
TR20	Trans. Sil. NPN 2N2369A				300552390

Cct. Ref.	General Description	Solartron Part No.
TR21	Trans. Sil. PNP BCY70	300553590
TR22	Trans. Sil. PNP BCY70	300553590
TR23	Trans. Sil. PNP BCY70	300553590
TR24	Trans. Sil. PNP SM6526	300552990
TR25	Trans. Sil. PNP SM6526	300552990
TR26	Trans. Sil. NPN BC107S	300553320
TR27	Trans. Sil. NPN 2N2369A	300552390
TR28	Trans. Sil. NPN 2N2369A	300552390
TR29	Trans. Sil. NPN BF257	300554120
TR30	Trans. Sil. NPN BF257	300554120
TR31	Trans. Sil. PNP BCY70	300553590
IC1	14 lead DIL SL3045	300554090
IC2	14 lead DIL SL3045	300554090
SW5	Switch Push Button	379601001

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